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TABLE OF CONTENTS

LEADING ARTICLES: Page

The New Masonry Arch Bridge at Plauen, Saxony, and Two Bridges in the Black Forest (illustrated); W. J. Douglas. 155

Breakwater Construction and Rock Excavation at Port Colborne Harbor (illustrated); J. M. Hogan. 158

The Employment of Restraining Culture Media in Testing the Hygienic Efficiency of Sand Water Filters; A. Robin. 160

Recreation Buildings for the South Park System, Chicago, Ill. (illustrated). 162

The Prevention of Stoppages in Gas Services, Meters and House Pipes During Cold Weather; Irvin Butterworth. 163

Concerning Retaining Walls and Earth Pressures (illustrated); H. P. Boardman. 166

Blue Print Apparatus with an Ordinary Window as Glass and Part of Frame (illustrated); H. O. Gorman. 169

Daily Warnings as to the Safety of the Water Supply of Chicago. 169

A New Clam-Shell Dredge-Bucket (illustrated). 170

Calculating the Cubical Contents of Piling. 170

An Improved Form of Vicat Needle Apparatus (illustrated). 174

Graft in Mine Equipment. 174

Concrete Ties on the Lake Shore & Michigan Southern Ry. (illustrated). 175

Some Notes on the Development of Eye-Bar Manufacture (illustrated); Joseph H. Springer, Sr. 175

EDITORIAL. 171

Water Stoppages in Gas Services—Schemes for Relieving Chicago Streets from Freight Traffic—Compensation of Engineers in the Government Service at Panama and Manila—Differences in Practice in Intermittent Filtration in England and America.

The Abuse of the Lecture Method of Teaching Engineering Subjects. 171

LETTERS TO THE EDITOR.—Labor Distribution Accounts, Maintenance of Way Department, Fredericksburg & Potomac R. R.; J. H. Eby—Further Conditions on Graft in Engineering; "A. B. I.," "Superintendent," "Professional."—Suggestions on Surveys for Mapping the Location of Buildings on City Streets (illustrated); Charles E. Smith, Tyrrell B. Shertzer, Bruce L. Cushing—A Young Engineer's Optimistic View of Conditions on the Panama Canal; W. D. Taylor. 172

ENGINEERING NEWS OF THE WEEK. 177

PERSONALS. 178

ENGINEERING SOCIETIES. 178

THE NEW MASONRY ARCH BRIDGE AT PLAUEN, SAXONY, AND TWO BRIDGES IN THE BLACK FOREST.

By W. J. Douglas.*

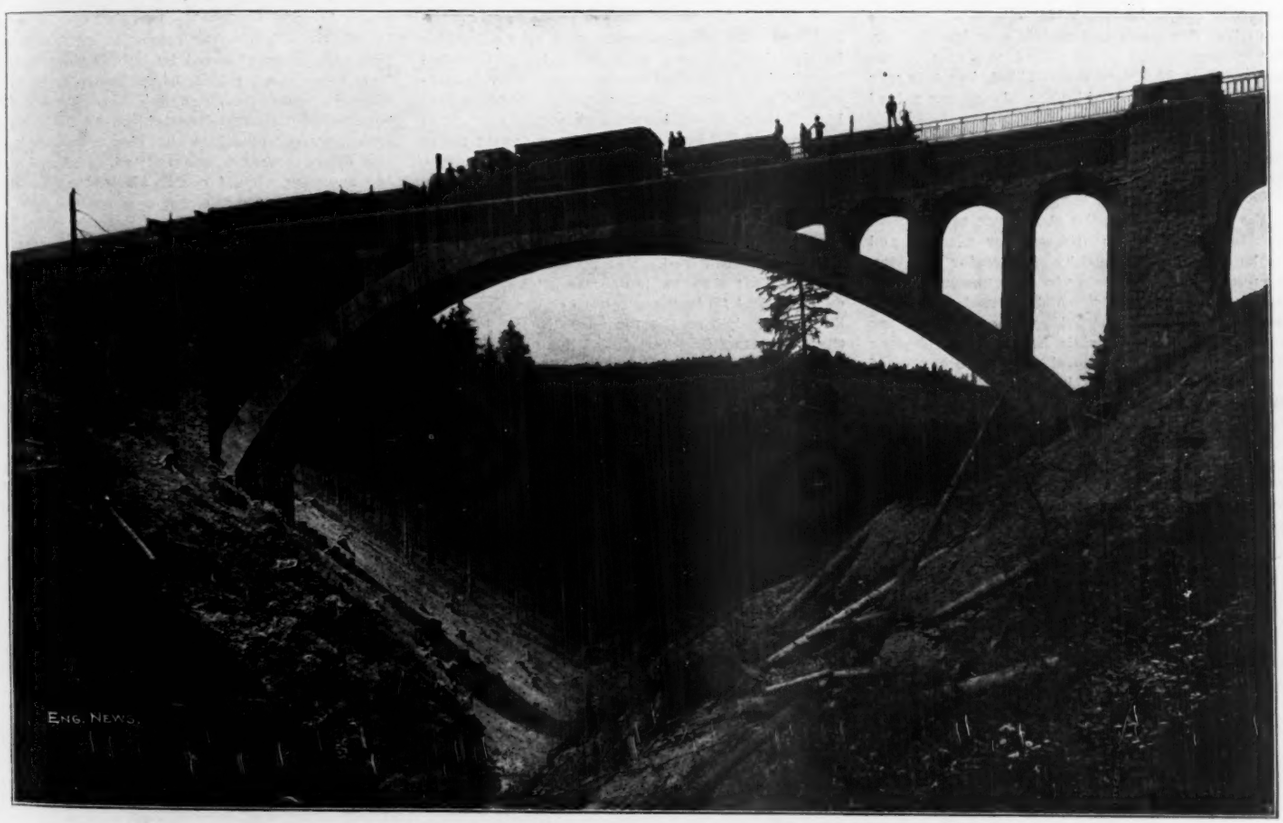
The admirable work done by European engineers in recent years in masonry arch construction is excellently exemplified by the three great structures whose pictures are presented in the accompanying engravings. One of these views shows the recently completed "Plauen Viaduct" which has the longest stone arch span in the world, and the others show two equally interesting masonry arches located on the Neustadt & Donaueschingen railway in the German Black Forest region. The two Black Forest bridges command attention at once as particularly handsome arches of unusual span, and while the Plauen Viaduct merits scant praise for its beauty, its remarkable span of arch and small rise make it a noteworthy feat of engineering design and construction.

In June, 1904, the writer visited the Plauen arch, which at that time was only partially completed. The centering for the main arch was still in place and the face walls were practically completed up to the level of the roadway. The most interesting thing to be noted, perhaps, was the great amount of lumber used in the centering. This was all small stuff, approximately 6×6 ins., 8×8 ins., 2×8 ins. and 3×8 ins., and apparently about equal to an inferior quality of merchantable long leaf pine. The second thing that was particularly notable was the fact that the only machinery that they had on the work was that used for mixing mortar, excepting that there was a runway or incline for a narrow-gage car, which apparently was used to carry the rubble stone to different points of the work. No work was in progress at the time of the visit, and in consequence no details can be given from personal observation of the methods pursued.

The writer is indebted for the following details of the bridge to two articles written by City Engineer Fleck of Plauen for the "Deutsche Bauzeitung" of July 16 and 20, 1904; the photograph and drawing reproduced here were furnished him by the contractors for the work, Liebold & Co., of Langerbrück, near Dresden.

Proceeding now with the description of the bridge, it is first to be noted that the city of Plauen is divided into several small suburbs by the River Elster and a number of other smaller valleys, among which is the one known as the Syratal, spanned by the new bridge. Traffic between the main city and the section or suburb on the opposite side of the Syratal had grown so as to make a bridge connection imperative. As the result of an announcement in the newspapers that the city was about to build a bridge, a number of the best known German construction companies solicited permission to submit plans. Consent was granted and it was decided to leave the choice of the structural material as well as the design to the competing concerns; this was done with the idea of obtaining a comparison between the cost of a steel and a stone bridge.

Twenty-three sets of plans were submitted. Of these six were for steel bridges, twelve were for



SCHWAENDERHOLZ BRIDGE ON THE NEUSTADT & DONAUESCHINGEN RY., GERMANY.
(Span, 187 ft.; rise, 55.8 ft.)

*Engineer of Bridges, District of Columbia, Washington, D. C.

iron bridges, four were for reinforced concrete bridges, and one for a stone arch bridge. Much to the surprise of every one, the stone arch design proved only a little more expensive than the cheapest of the designs in iron. This design, as originally submitted, however, called for three rubble stone arches, and while it was decided to build a masonry structure because of its comparative cheapness, it was also decided to change the design by substituting one arch of 90-m. span in place of the three smaller arches. This change was prompted by the necessity of providing for the greatest possible freedom for traffic under the bridge and by the unstable character of the ground at the north and middle pier foundations. The change in the plans raised this cost of the bridge about 15,000 marks ($3,570), but this was thought to be warranted by the advantages gained by doing away with piers.

The adopted design is shown by the view and the drawing. The main arch, which rests upon the banks of the valley, has a clear span of 90 m., or 295.2 ft., and is the longest masonry arch in the world. One of the abutments of the main arch is pierced by an archway for a street and the haunches are pierced by six circular galleries, the purpose of these being to save masonry. Except for these openings, which detract materially from the beauty of the bridge, the spandrels are solid, solid retaining walls being found cheaper than secondary or spandrel arches because of the great width of the bridge. The walls are finished with the coping resting on projecting buttresses or consols, which construction also widens the bridge floor. To relieve the center portion or the crown of arch ring, the roadway is supported on longitudinal spandrel arches which are covered with light coke ash; otherwise the spandrel filling is earth and sand. The most important dimensions of the bridges as described are as follows:

Item.	Meters.	Feet.
Span of main arch	90	295.27
Span of abutment arch	13.2	43.31
Width between railings	17	55.72
Width of roadway	11	36.1
Width of sidewalks, each	3	9.84
Thickness of arch at crown	1.5	4.92
Thickness of arch at skewbucks	3.4	11.154

The main arch has three centers with a radius for the crown arc of 105 m. (344.48 ft.), making it the flattest curved arch ever used in a stone bridge. From an aesthetic point of view a greater rise would have been desirable, but it was not possible on account of the grade of the approaching streets. As it is, one end of the bridge required high spandrel walls and to have increased further their height would have added to their cost; the cost of the approaches would also have been increased by a greater rise. To avoid the apparent sag of long level line, the bridge floor rises on a grade of 1 in 240 from each end toward the center; the approaching streets have grades of 1 in 22 and 1 in 29, respectively.

From a static view the main arch is divided into an elastic arch of 65 m. (213.25 ft.) and two arch abutments, which, because they abut against solid ledge rock were considered immovable. The investigation of the stability of the arch was made "on the basis of well known graphical and analytical methods, and also according to the elastic theory with the help of influence lines." The following moving-loads were considered in making the calculations: (1) A 15-ton vehicle 3 m. (9.84 ft.) between axles and a uniform live load of 500 kgs. (1,235 lbs.) per square meter (114.6 lbs. per sq. ft.). (2) Three steel rollers, aggregate weight 22.64 gross tons, and a uniform live load of 575 kgs. per square meter (104.8 lbs. per sq. ft.). As was expected, the influence of the movable weight was small when compared with that of the dead load. The greatest pressure, including that due to temperature changes, was calculated at 69 kgs. per square centimeter (981.4 lbs. per sq. in.) on the top edges of the joints at the crown, and 52.4 kgs. (745.1 lbs. per sq. in.) on the lower edges of the joints. With these pressures the factor of safety, considering the mortar used, was everywhere at least 3½ after 45 days. The greatest pressure on the foundations is 25 kgs. per square centimeter (355.58 lbs. per sq. in.), and the foundation throughout is upon massive unweathered rock having a crushing strength of 1,600 kgs. per square centimeter (23,757 lbs. per sq. in.). In excavating for one of the foundations, however, an abandoned mine was unexpectedly encountered, and in order to make the foundation perfectly secure those openings in the line of pressure were filled with masonry and the pressure distributed by means of steel beam grillages. The cost of this work was 13,000 marks ($3,094).

The question whether the arch should be made with or without articulate joints or hinges was, after detailed examination, decided in favor of the solid arch. The decisive reason next to that of cost was that there is a reasonable question whether or not under the very high pressures involved articulate joints would work satisfactorily. The fact that the necessary materials for the arch could be brought upon the site b[e]fore beginning the work, so that they could [b]e placed loose upon the sheeting before the maso[n]ry was laid up in mortar, thus giving the center[s] the form it was to assume in the finished ar[ch] was a decisive factor in the selection of the m[a]terials to be used in the construction of [t]he bridge. By thus loading up the centering bef[ore] building upon it, the settlement of the foun[da]tions and the shrinkage of the lumber under pr[es]sure was made to take place by this tempor[ary] loading thus decreasing the possible amount [of] deformation of the centering during construct[ion].

FIG. 1. VIEW OF 295-FT. MASONRY ARCH BRIDGE AT PLAUEN, SAXONY.

The building stone for the Plauen arch is thick flag-like carpolite. (The writer is not familiar with carpolite, but the stone used appeared to him to be a hard stone of shale or schist) having a green-bluish color with regular split beds and a crushing strength of 1,600 kgs. per square centimeter (23,757 lbs. per sq. in.). It was taken from quarries 12 kilometers (7.456 miles) from the bridge. Before using, the stone was cleaned with water under pressure from the city waterworks.

The mortar is composed, for the foundation of the abutments, for the main walls and wing walls, and for the longitudinal spandrels, of one part Portland cement and four parts sharp sand, and for the

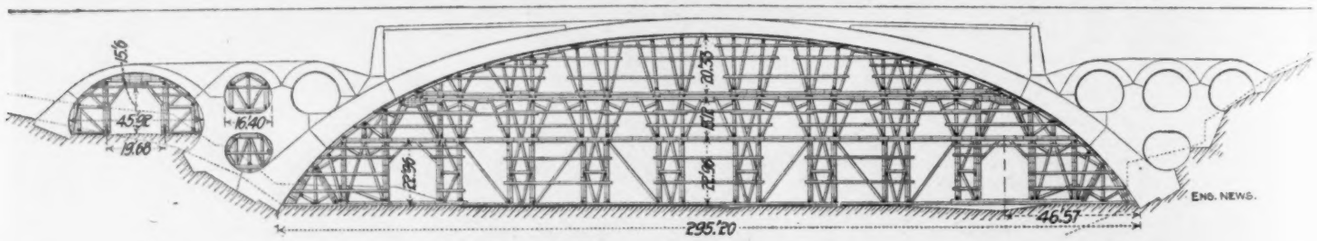


FIG. 2. CENTERING FOR PLAUEN ARCH.

main and secondary arch, of one part Portland cement and three parts sand. The mixing was done mechanically in an electrically driven machine. As stated herein by the writer, this was the only piece of machinery that he saw on the ground. Only cement was used which, after a test of 5 days (1 cement to 3 sand) was found to have a compressive strength of 407 kgs. per square centimeter (5,788.8 lbs. per sq. in.), and a tensile strength of 40 kgs. per square centimeter (568.92 lbs. per sq. in.). These figures are the result of from 5 to 10 tests.

the stairway walls, the steps and step railings, the curbing and the paving of the roadway were all of granite.

The water-proofing consists of asphalt sheets laid upon a bed of cement which made a smooth surface for the sheets.

Special consideration was given to the construction of the centering because upon its stability depends the success of the construction of the arch. The centering is built in three stories, as shown by Fig. 2. Between the second and third stories wedges are placed for the purpose of adjusting and striking the centers. The number of longitudinal ties in the uppermost story is 21; these ties are continuous. In the other two stories there are only eleven ties, with the exception of that portion between the springing line of the arch and the continuous longitudinal ties. In this latter case there are 21 ties. In general, only square-edged, full-sized timbers were used, as indicated on the drawings. Special stress should be laid upon the care with which the masonry foundations for the centerings were laid. In general, it can be said that in the construction of this centering a great deal of precaution was taken. For every two cubic meters of masonry there was one of wood. The centering was not made at the site of the work, but in the yard of the firm of Liebold & Co. in Langebrucke, and was shipped from there to Plauen. The transportation of the timber required 90 double cars, and the transportation of the iron bolts, screws, etc., required two single cars. The building of the centering required 3½ months.

The provisional roads which had to be made for the traffic on Dobenau St., and also for the approach to the brewery, hindered the work considerably. For the execution of the general work, and particularly for the transportation of the rubble stone and mortar, two auxiliary scaffolds were constructed, one at half the height of the bridge, and the other at the full height. Both of these trestles were built so that they have sufficient fall towards the bridge to let the cars run down without labor. Through this arrangement was obtained great simplicity of supervision and of construction. In order to work at night the place was lighted with arc lights. The preliminary grubbing of the place was begun on March 26, 1903. The foundation of the abutments was begun Aug. 1, 1903. The masonry of the main arch was completed Nov. 8, 1903.

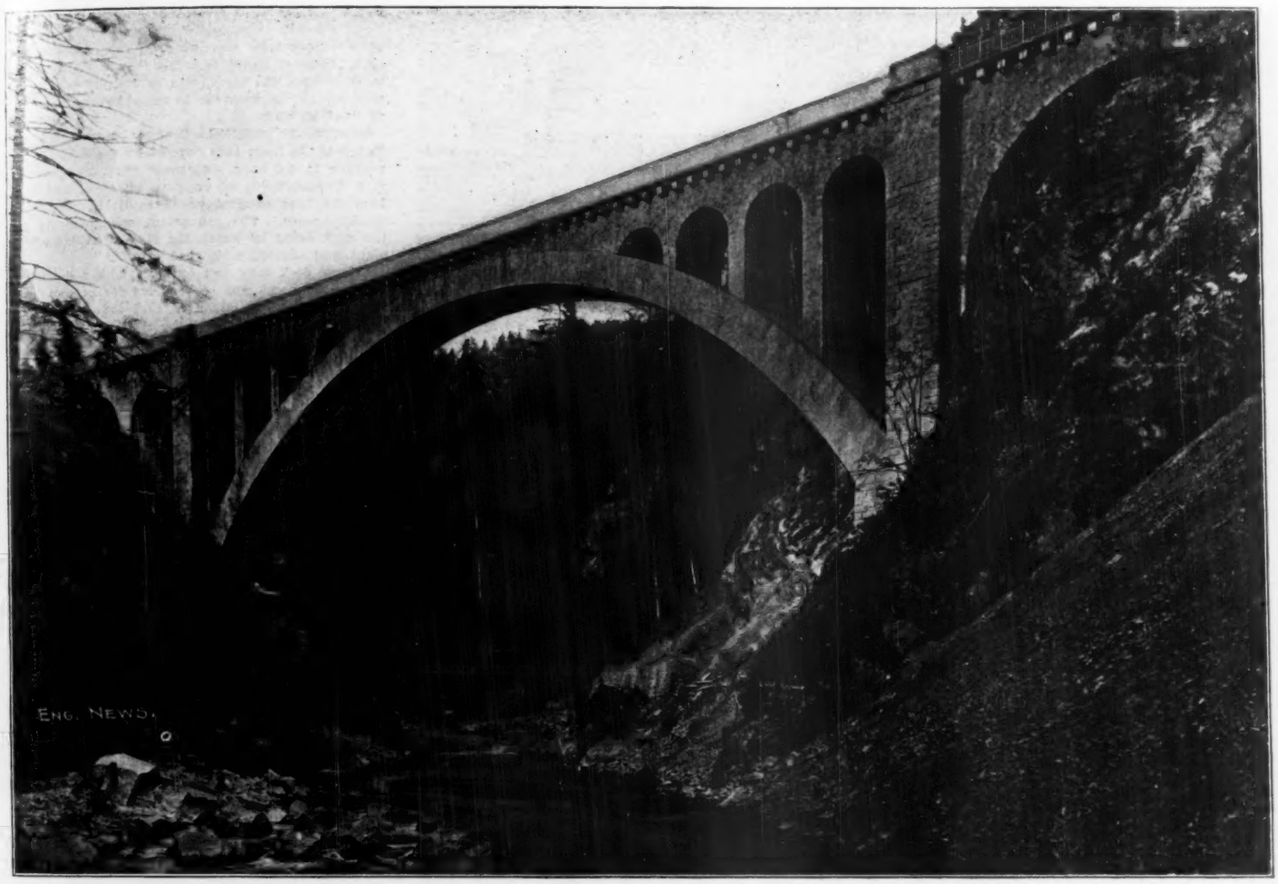


FIG. 3. GUTACH RIVER BRIDGE ON THE NEUSTADT & DONAUESCHINGEN RY., GERMANY.
(Span, 210 ft.; rise, 52.5 ft.)

The shape of the rock of which the bridge is built enabled the contractor to have perfectly radial joints in the arch work. The showing faces of the ring stones are covered with a mortar of one part cement to five parts silver sand, which is made to simulate granite, and in which square block joints were marked off by means of battens nailed to the lagging of the forms. To have employed a solid granite facing would have entailed an impractically high cost; it was also deemed advisable not to disturb the homogeneity of the arch. The hardened mortar faces of the arch ring were tooled to simulate cut granite.

The following method was pursued in making the mortar covering. It had a thickness of 2.7556 inches and was put on moist and thrown against the template forming the grooved joints. By this means a very close bond was obtained between the mortar facing and the stone. It was the intention by using this method to overcome the tendency of the mortar to slough off from the masonry, which always occurs if the mortar is plastered on. All outer surfaces, excepting the faces covered with the mortar as just described, are of hammered rubble stone which was pointed up upon the completion of the work, excepting that the projecting cornices, the solid part of the railing, the large stones of the wing walls, and

The following are the principal figures of cost:

	Marks.	Dollars.
Masonry, earth and rock excavation..	380,900	90,582.80
Construction of the roadway.....	53,300	12,685.40
Railing.....	8,000	1,904.00
Lighting plant.....	6,000	1,428.00
Conveying canals and sluices.....	3,200	761.60
Changing roadways.....	1,800	428.40
Supt's and testing of materials.....	9,000	2,142.00
Building interest.....	15,000	3,570.00
Leveling off the place under the bridge and contingencies.....	35,900	8,544.20
Total.....	512,800	122,046.20

Mention being made above of the railway arches in the Black Forest between Neustadt and Donaueschingen, Germany, the writer presents views of these two structures in Fig. 3 and the first page engraving.

WORK ON THE NEW YORK BARGE CANAL is now well under way. Six contracts were awarded several months ago, and on three of these ground has been broken. One is at Rochester, another is at Waterford, and the third is at Fort Miller. Work on the fourth contract was started last week, between Cracker's Reef and Fort Edward. This contract involves a large amount of dredging and was awarded to Lindon W. Bates, of New York City, who has been doing the work on the Galveston, Texas, sea wall. The Canal Advisory Board has decided to enlarge the proposed locks, making them 45 ft. wide and 12 ft. deep. The original plans provided for locks 28 ft. wide and 12 ft. deep. The new locks will permit the passage of barges which now reach the seaboard through the Canadian canal system.

BREAKWATER CONSTRUCTION AND ROCK EXCAVATION AT PORT COLBORNE HARBOR.*

By J. M. Hogan, S. Can. Soc. C. E.

The works comprise new docks, excavation of channels, and two large breakwaters to east and west of the port. These breakwaters, of which one, 5,000 ft. long, is totally finished, while the other, 2,400 ft. long, is half completed, are under the supervision of Department of Public Works. The rest of the works are in the Department of Railways and Canals. This paper will discuss only the latter.

The work may be divided into outer harbor and inner or canal basin. The former calls for the construction of two docks, 200x700 ft., and the deepening of an area

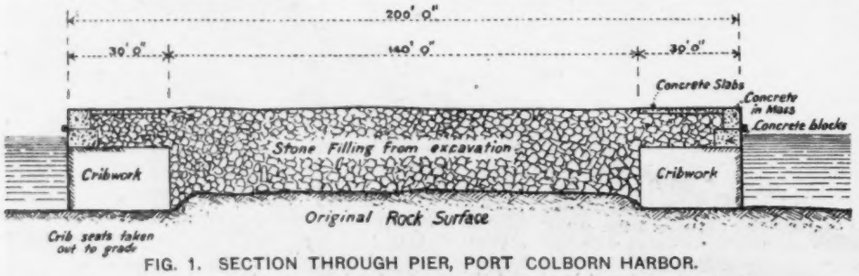


FIG. 1. SECTION THROUGH PIER, PORT COLBORN HARBOR.

to 22 ft. to allow approach by largest lake carriers. The excavation shown is entirely of solid rock, over 300,000 cu. yds. in all, averaging a cut of 3 to 4 ft. from lighthouse to canal basin entrance a depth of 18 ft. is required, principally sand and soft material. The canal basin itself is dredged to afford 16 ft. of water. This plan, however, will no doubt be changed to afford a depth of 22 ft. over entire area of both inside and outside harbor. In addition the sides of the canal basin have been dug out and concrete docks built.

DOCK DESIGN.—Design of inside and outside harbor docks is similar save for width of crib. Fig. 1 shows a section through the pier, which is essentially submerged crib work filled with stone, and surmounted by concrete blocks carrying a mass concrete wall, the whole covered for width of crib by an 18-in. slab of concrete.

These cribs are built to within 2 ft. of an assumed water surface (14 ft. above miter sill of lock) so that no timber is exposed to rot. The use of concrete blocks does away with the difficult operation of placing green concrete under water, and ensures a lasting job in a position where permanency is required. Crib seats were in all cases dug out to grade with dredges, but the interiors of outer docks were left as found.

CRIBWORK.—Fig. 2 "C" shows details of cribs. The outer harbor cribs were 30 ft. wide as against 20 ft. for inner harbor, the extra width being called for the exposed position. The construction points do not vary beyond the extra solid bulkhead in the 30-ft. crib.

The timber used, about 35,000,000 ft. B. M. in all, was all 12x12-in. square hemlock, proud edged with small quantity of wane allowed in ties or longitudinals. A small quantity of 6x12-in. is used for bottom grillage and block seat.

Ties and longitudinals are dovetailed, as per sketch, preventing the possible pulling apart or crushing in of cribs. They are placed at intervals of 10. ft.; except in lower course, where an extra tie is put in every 5 ft. Side joints are simply butted, ends being cut exactly square with ¼-in. allowable opening. End joints lap alternately. The longitudinals form two solid bulkheads for full length of the crib, which is a feature of great strength. This calls for short 10-ft. fillers between ties on every second course.

Binders are placed every 20 ft. with the object of tying the face courses together vertically so they might not have to depend upon bolts alone to prevent them being forced apart.

Binders are fastened to face timbers and ties by 1¼ x26-in. screw bolts with square plate washers.

The three lower courses of crib are made specially strong to withstand stresses caused by filling, weight of wall, contact with uneven bottom, and rough usage in handling, etc. They are fastened with 1¼x36-in. screw bolts and washers passing through whole three courses and spaced 5 ft. apart. The other courses are bolted as shown with 1¼x32-in. drift bolts having sheared points. These bolts pass through two entire courses and partly into a third.

The short blocks shown in section, coming almost under the rear of concrete block, aid in preventing any deformation of tie and consequent settling of wall.

These cribs are built on ways up to 7 or 8 courses, and then launched and finished in the water. Owing to depth of water in basin being insufficient to float a finished 20 course crib, it was necessary to tow cribs into the open lake, and finished them near their sites.

Cribs were built by derricks afloat on scows. A feature was the placing of the derrick at the edge of the scow (Fig. 3), and so arranging the stiff legs that derrick boom could have greatest possible radius of action. Only one move was required by scow to lay a whole course of timber. Hoisting engines having boom fall and swinging drums were used, so that the engineman controlled the whole movement of a stick of timber. The timber was unloaded from vessels directly into the water in piles or moulinettes; this being the only and most convenient method of storing the enormous quantities of timber used. As required, the moulinettes were towed alongside the crib scows and built directly into the cribs. The timber was thus placed in the crib with only one handling, as the ship was bound by contract to unload its own cargo.

Crib scow also had an air compressor plant to supply pneumatic augurs used for boring, as all drift bolts were driven into holes bored ¼ to ⅛ in. too small.

A gang of 20 men in all launched two crib bottoms of 7 courses and binders regularly each week, while a completed crib represented about 8 days' work.

Cribs were sunk by placing on them several concrete blocks on temporary platforms at ends and middle. When properly alined and level the filling was dumped in as rapidly as possible, and blocks later placed in their proper position. Owing to weather conditions the filling of each crib had to be completed at once, or about 2,000 cu. yds. of stone filling provided. All this filling was dredged up from the "yellow" area already referred to.

CONCRETE BLOCKS.—These blocks, 4x4½x7 ft., were molded in timber forms made of 2-in. dressed pine, tongue and grooved. A piece nailed to side of mold gave required joggle to block. The molds (Fig. 5) were tied across by two ⅝-in. round iron rods with nuts, threaded both ends. The lower rod passed through the partition forming end mold of block.

Sides were held in position by shoulder formed by lapping on 8x4-in. upright. To remove molds, nuts are slacked and uprights taken down, when the sides will remove in one piece and are utilized again. These molds were filled with concrete in layers and allowed to set for 48 hours before removal of molds.

In top of the block is seen a basin-like depression, while in the side a slot or joggle is molded. When blocks are placed side by side, the mass concrete of wall filling up joggles, etc., forms a strong joint between each block and between top of block and wall above, and prevents any lateral displacement of blocks relative to the wall which might be caused by impact of the heavy seas or vessels.

The joggle also allows of the simple method of handling the blocks shown in Fig. 4.

Much difficulty was experienced in setting these blocks level and close jointed; especially the latter. This is due to the uneven character of the bed left by the filling in of stone filling and the difficulty of leveling same in 2 to 3 ft. of water. As an aid to obtaining close joints the blocks are now made with a bevel 1 in. from face to rear of block which allows of the face being brought closer to the neighboring block.

Molds for concrete wall are of similar material to block molds and similarly fastened, except the lower rod, which rests on the block and supports outside upright which overhangs the face of wall. This rod remains in the wall. The rear upright is wedged into joggle. Molds were erected in sections of 60 to 70 ft., a day's work. The next day's work began at finishing point of previous day, which allowed sufficient expansion. Canvass nailed to inside face of mold and allowed to drape over the block, was extensively used to prevent washing out of concrete by seas before thoroughly set at level of block.

CONCRETE MIXING.—Concrete was 1:2:4 mixture. Owing to the large area covered by the works it was impossible to set up a permanent plant anywhere, as the slow transportation of concrete by scow, and the extra handling thus entailed would result in poor work and much expense. The convenient approaches to most of the work being by water, the plan of utilizing a floating plant was adopted with good results.

A large deck scow was equipped with a derrick, mixer, and crusher, and storage provided for cement and sand. The lay-out was so arranged that the derrick, having a 88-ft. boom, controlled all the operations. Materials for the day's work were loaded each morning, and the scow towed to the site. The stone for crushing was obtained directly from the back filling of the cribs and hoisted to the crusher platform in tubs, where two men fed it continually to the crusher. This stone, being dredged from the bottom of the lake, was clean and excellent for concrete. The stone thus crushed runs out below into another skip or tub. When 3 or 4 ins. have accumulated the spout door is closed and a wheelbarrow of sand from the pile close at hand is dumped in and spread, followed by two or three bags of cement. This alternate process is continued until the box is filled, when it is hoisted up and dumped into the incline bin of the mixer, and thus runs in a continuous stream through the mixer itself and into molds below. Besides being continuous, this system is compact and has great range. Where stone was not available from filling it was brought alongside in scows and used as wanted.

The gravity mixer used consists essentially of a sheet iron spout having small iron rods placed to line of flow to give a tumbling or turning over motion to the concrete. A perforated pipe, controlled by a valve sprays water over the dry mixture as it passes. A door at the bottom of spout is operated by a man, who also controls the water. The door is kept closed till the lower chamber of the spout is filled when concrete is released and door closed for another batch, about two shovelfuls.

A large boiler on the scow provided steam for hoist, crusher and engine, and small pump, which fed mixer.

An average day's work consisted of 65 to 75 yards for a gang of 18 Italians, foreman and hoistman, or about 50 cts. per yard for labor. Cement used (at least 10,000 barrels to date) was Rathbun "Star," made in Deseronto, Ontario, and the results obtained have been excellent.

The mixer moved on tracks, and both could be lifted off and set up on a wall within radius of boom, and the

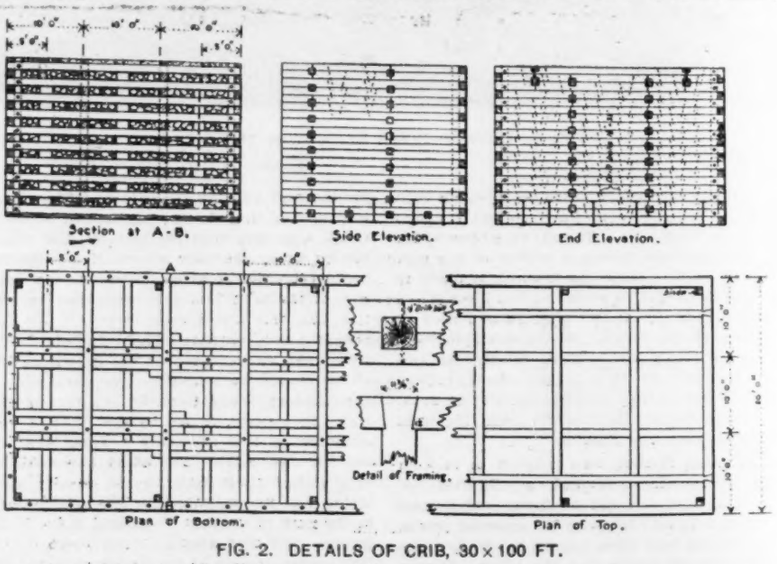


FIG. 2. DETAILS OF CRIB, 30 × 100 FT.

*Slightly condensed from a paper read before the Canadian Society of Civil Engineers, Feb., 1905. A full description of the Breakwater will be found in Engineering News, May 15, 1902.

concrete process go on as before. Such a method was used in laying slab covering of docks.

EXCAVATION.—The principal item of this part of the work consisted of the drilling, blasting and dredging of 200,000 cu. yds. of very hard flinty limestone over a great area. The above quantity is in place, not scow measurement. The cut varied from 6 in. to 6 ft., but to get down to grade it was necessary to drill and blast at 2 to 3 ft. below the grade to avoid pinnacles and ledges being left. No payment is allowed, however, for this extra depth, except as filling. Owing to constant interruptions by storms this has been the most troublesome part of the work.

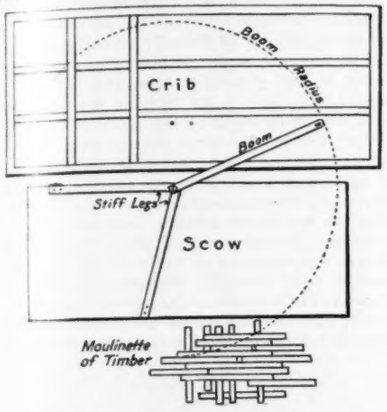


Fig. 3. Method of Building Crib.

DRILLING AND BLASTING.—To drill and blast this, a submarine drill boat is used, consisting of a specially strong hull, steel preferably, housed over and carrying the boiler, large steam pump drill frames, drills, and hydraulic feed for same.

The latest type used at Port Colborne, and built 1903, consists of steel hull 100 × 27 × 6 ft. of ⅜-in. plate (see Fig. 7), having cross and longitudinal trusses composed of channels and bracing. It will be noticed that the drill frame slide is specially strengthened by shortening the panel length in cross section so that panel post comes under drill frame, and also by the use of ½ × 12-in. plate and bracing longitudinally. The stresses are here a maximum, owing to constant pounding of drills and the impact of the blast underneath. Another feature is that scow ends, in place of the ordinary square form of design, the corners of which were soon opened by the blasting, and it was impossible to keep the boat tight. The boat is also easier to tow. The boat is pinned up, i. e., part of her weight, possibly 60 tons, taken on oak spuds 14 × 16 ins. at each corner. She is thus held in place. These spuds run in guides and have cast iron rocking sunk even with their face on inner side. A gear wheel attached to slides works in this rocking and lowers or hoists spuds. A single upright engine operates a series of shafting under deck which connects with this spud gear wheel. This is an improvement on the old method of an engine attached directly to each spud, as owing to these engines freezing up, no winter work could be done.

The drill proper is attached to a carriage composed of two angles latticed, and having a saddle at top. This carriage moves on two uprights, i. e., the drill frame. An hydraulic ram, working between these uprights and attached to saddle drill carriage takes the place of the hand feed on land drills. This ram is controlled by a three-way valve, by which the drill carriage is lowered or raised, and, of course, the drill with it. A large steam pump, to which is attached a governor to control the speed of pumping to requirements, supplies hydraulic power for ram. The drill bore is of 1¾-in. round machinery steel to which is welded a piece of 2-in. octagon steel to form drill shank. The drill, having 8½-in. stroke, is run by steam similar to land drill.

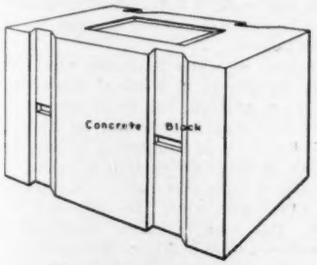


Fig. 4. Concrete Block.

Three drill frames are mounted on the boat on rails and movable by ratchet and level attached to the axle of the drill truck wheel.

To load holes a cylinder is used having a smaller diameter than the hole and of sufficient length to admit the whole cartridge. This cylinder is slotted on one side to insert cartridge and connecting wire. To cylinder is attached a long piece of 1-in. gas pipe coming well above the water. The drill bar being withdrawn, this apparatus is put down into the hole and a long pole, run down through the pipe, forces the cartridge from the cylinder into the hole. The loading apparatus is then withdrawn and charge exploded by battery.

Dynamite of 75% strength (as against 40% ordinarily used) is required for this work. Holes placed 6 ft. apart and loaded 7½ lbs. to an 8-ft. hole gives best results. The dynamite is made in sticks 1¼ ins. diameter and 3 ft. long, a stick weighing 5 lbs. The shock from a blast in 16 ft. of water is quite perceptible.

The following data compiled by the writer from foreman's reports, etc., show the results accomplished by one drill boat for the five months from April to August, 1904. Owing to the constant storms, which drive the boats from their ranges and the loss of time in getting back on said ranges, the records are not a measure of the actual capacity of the boat.

	Days of 12 hrs. worked.	Holes.	Feet drilled	Lbs. powder.	Ft. per hr. per 3 drills.
April	49	2,282	10,170	8,527	18.0
May	43	1,348	6,280	5,624	12.2
June	50	1,453	8,133	6,947	13.5
July	43	1,512	6,950	6,104	13.4
August	43	1,348	6,478	5,511	12.5

Days worked included the time to set up on ranges and the time the drill was on the range, but could not drill owing to weather. Night and day crews were worked. The time the drill lay idle in basin weather-bound is not included in days worked. The month of April shows larger results because the drill worked in a sheltered position in the canal. The depth of drilling seems to make little difference to average result as seen from June and July records, the depth of drilling in the former month being in excess of the latter. A deep hole requires an extra drill bar which takes time to insert, and deep drilling is also troublesome on account of binding, etc., but this is off-set by the extra blasting in shallower drilling, and loss of time in starting holes.

The best performance, as indicated by the record, was the drilling of 323 holes, or 1,615 ft., in 72 hours, day work, from April 4 to 9, or an average of 22.4 ft. per hour, per three drills. Best day's work was 315, or an average of 27 ft. per hour.

DREDGING.—The dredges used to dig this rock are of recent construction, i. e., 1902 and 1904, and possess great power. The hulls are of steel ½-in. plate at sides and 1-in. at bow. The dredge is pinned up on two forward spuds (Fig. 8) 36x36-in. oak running in slides. These spuds form the front corners of the hull, which gives a clear side with no projections to be knocked off at the stern (scow type). A single spud 20 ins. square placed in center of boat and at an angle to the vertical holds boat up against the bank, and prevents swinging. This spud is geared similar to drill spuds, and has a separate engine, while forward spuds are operated by cables from main engine. The feature of the hull is the extra strength of machinery Kelsons, which instead of being small I-beam box girders, consists of stiff truss the depth of hull and fastened to deck channels above, as well as to floor or bottom of boat. This greatly stiffens the vulnerable part of the boat, the bow, and prevents working of Kelsons under the pull of the engines and consequent opening of bottom and bow plates. Another feature is the carrying of the overhead truss the full length of the boat, thus affording a secure fastening of the stern anchors and a better distribution of the stress it exerts, besides adding to the general stiffness.

The power is got from two 18x20-in. horizontal engines fed by Scotch Marine Boiler 11x13-ft., furnishing 140 lbs. pressure. A small pinion on engine shaft operates a larger pinion on a shaft, to the ends of which are attached two more small pinions operating the main hoisting drum, which is 8 ft. in diameter. The first series of shafting is extended in bearings to the sides of the boat, and has attached to it the drums for lifting spuds. When boat is pinned up these drums are thrown out of gear and spuds held up by friction brake, operated on deck by the crew. To lower away the dredge it is only necessary to slack the friction brake.

The hoisting cable is of 2¼-in. wire rope, and when in digging anything specially hard is encountered care has to be taken or the dredge will snap this cable-like rope. The average life of a cable in digging rock is not over a month. The dredges are of the single whip variety, no system of pulleys or blocks being used on crane to obtain power, but a single line of cable from drum to bucket. Anchor cables are of 1¼-in. wire rope, while a special engine and 1½-in. test chain is used for swinging.

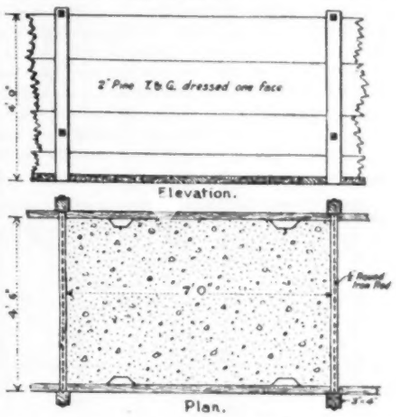


Fig. 5. Concrete Mold.

These dredges operate a 4-yd. bucket. Their performances vary greatly, for the frequent hauling of drills from ranges for safety causes many undrilled areas of small extent, which make difficult and almost solid rock dredging. As little as 250 yds. a day is sometimes got. Tests taken of the new 1904 dredge in well drilled material loaded in skips of 5 yds. capacity showed an output of 4,385 cu. yds. in 6 days of 12 hours. Deducting five hours delay for repairs, this gives an actual average of 65.5 cu. yds. an hour. No effort was made for a record. Her best performance was 1,000 yds. (in tubs) in 12 hours. These are rock figures, the dredges never having been tried in soft material.

The excavation is loaded in dump scows or tubs, according to the purpose for which it is required. No filling can be done by dump scows in less than 7 ft. of water. To handle skips, a large A-frame steel derrick with 65-ft. boom, capable of lifting 20 tons, was built. To carry this a special scow 120x36x11 ft. was built, having steel trusses, etc. Owing to its breadth and stiffness it was possible to lift to the capacity of the derrick without any pinning-up apparatus.

While this derrick was an experiment it proved most successful, being easier to handle and tow than regular speed derrick, and besides requiring no time to pin up, it provided a large space for carrying materials.

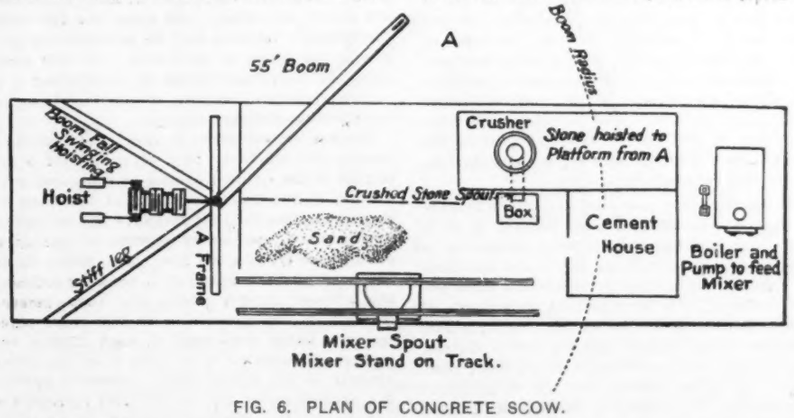


FIG. 6. PLAN OF CONCRETE SCOW.

These works are now almost completed. The tenders for putting in foundations for a 2,000,000 bushel elevator are under consideration, and with the erection of this elevator Port Colborne will possess a harbor equal to the best.

The work has been done by contract (Hogan and Macdonell, contractors.—Ed.) under enormous difficulties. Many of the features were new, and of the experimental

character, which required new devices and new methods. The weather proved a constant menace, summer and winter, time and again storms having wrecked cribs, sunk scows and drill boats, and driven the fleet into the harbor and twice below the canal locks for shelter. With the system of breakwater erected such a state of things can no longer prevail.

THE EMPLOYMENT OF RESTRAINING CULTURE MEDIA IN TESTING THE HYGIENIC EFFICIENCY OF SAND WATER FILTERS.*

By A. Robin,† M. D.

A critical review of the records of efficiency of sand filters together with direct evidence obtained from experimental work along this line have convinced me that the method generally employed for testing filters possesses serious defects which render it of little value. It is now known that the number of bacteria developing on a culture medium will depend on the composition, reaction and method of preparation of that medium, as well as on the conditions of cultivation. What is more, different bacterial species will behave differently on different media, and even on the same medium with slight variations of composition, reaction or methods of cultivation.

The use of some one medium, either agar or gelatin, in plating both the raw water and effluent eliminates the error introduced by the use of different media, but does not eliminate the important factor of variability in the behavior of different species of bacteria on the same medium.

The process of sand filtration causes a redistribution of bacterial species in the raw water and effluent; in other words, the percentage of bacteria in the effluent on the basis of that of the raw water does not represent an equal reduction in the number of bacterial species.

If, for instance, the raw water contains 10 bacterial species, the effluent may contain 2 or 5, depending on whether the majority of species in the raw water were such as to readily succumb to the process of filtration or were of a more resistant variety. It is obvious that as a result of the redistribution of species effected by filtration, the effluent may contain species which do not develop readily on agar or gelatin at room temperature, and these species may be in predominating number. Consequently, the bacterial count on the effluent plates will not represent the actual number of bacteria present, nor can this apparent number be compared with the apparent number of bacteria in the raw water.

In the following table is shown the relation of the number of bacteria developed on lactose agar, under anaerobic conditions, at 38° C., to the number developed on Nahrstoff-Heyden agar at 20° C. The former represent the bacterial species capable of developing at 38° C., i. e., exclusive of most of the saprophytic organisms, while the latter shows nearly all the bacteria present in the water.

The Nahrstoff-Heyden agar was prepared according to the original formula of Hesse and Niedner (Zeitshr. f. Hyg., Vol. XXIX., p. 454). The lactose agar contained 1% lactose, and each plate after it was solidified was covered with an agar jelly composed of agar 1.2% and water. This film placed the bacteria on the plate under anaerobic conditions.

Table I. shows that the proportion of toxigenic bacteria to the total number is different in the raw water and effluent. Of course, the table lacks the evidence of the kind of species which the respective numbers represent, and the figures, therefore, should be taken as a general rather than specific indication of the redistribution of bacterial species effected by the process of filtration.

Aside from the evidence furnished by the above table, there is the common observation that the superficial character of colonies in the raw water and on the effluent plates are very seldom the same. On gelatin there may be more liquefiers on the one or the other. On agar, the spreader or chromogenic colonies may be predominant in the one or the other of the plates. All this goes to show the unreasonableness of establishing a percentage relation between numbers of bacteria representing different species.

Another serious error in the general method of testing the efficiency of a filter is that a given sample of the effluent cannot be compared with a sample of the raw water taken at the same time, or at any time for that matter. The underdrains represent a filtered water reservoir of considerable total capacity. As the raw water filters through the sand into this reservoir it becomes diffused in the effluent already there, and the number of bacteria in any given c. c. of this fresh effluent becomes either diminished through dilution or increased by addition of bacteria from the effluent already in the underdrains. Generally speaking, the applied water and the effluent represent two communicating streams, bearing to each other the same relation as exists between surface and underground waters. While the bacterial flora of one is determined by the bacterial flora of the other, yet, owing to biological activities and the marked difference in the environment, the bacterial flora of each maintains in a large measure an independent existence. It is, of course, self-evident that the number of bacteria in the raw water will in general influence the number in the effluent, and the time when this influence will become apparent cannot be determined with absolute certainty.

In the records of the filtration plants of Albany, Lawrence, and our experimental filters we have numerous instances where the number of bacteria in the effluent on two or more successive days is gradually diminishing, while the number of bacteria in the raw water on the corresponding days is on the increase, and vice versa; or the diminution in the number of bacteria in both may proceed in an unequal ratio. Thus, to cite one of a numerous instances, the number of bacteria on agar in the effluent of Filter No. 3 on Jan. 21 was 300; in the raw water, 18,700. On the 22d the number in the effluent was 50, and in the raw water 1,050. Here is an instance where the effluent was much purer on the 22d than it was on the 21st, and yet the percentage efficiency on the 21st was 98.4 and on the 22d, 95.3. In other cases the number of bacteria in the effluent remained the same on three successive days, while the number in the raw water differed, and as a result the percentage efficiency differed from 1 to 3%. On one day the efficiency of Filter No. 3, which had generally been over 99%, dropped to 91.1, and yet the number of bacteria in the effluent was 98, and not much higher than on the preceding date when it was 69 (efficiency 98.4%), the reason being that on the day when the filter showed such apparently gross inefficiency the number of bacteria in the raw water was 1,100. Such instances could be multiplied almost indefinitely, but they would show no more than those cited, namely, the unreliability of a standard which permits of such marked variations.

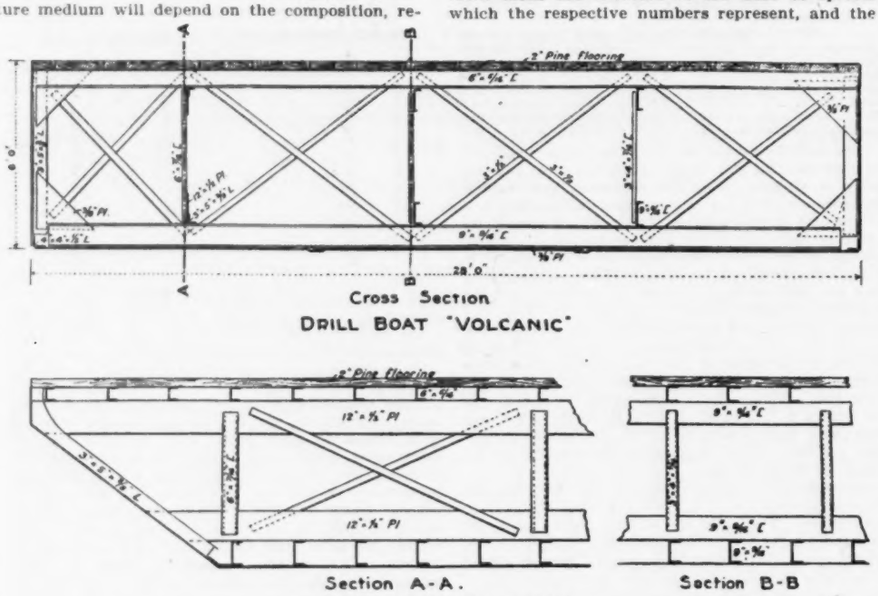


FIG. 7. STEEL DRILL-BOAT.

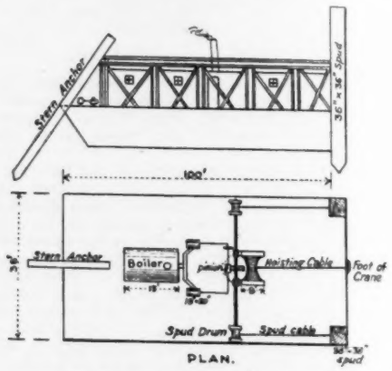


Fig. 8. Dredge, Showing Spuds.

Another source of error lies in the fact that while the raw water is usually diluted 1:50-1:100, the effluent is not. Any error of omission or commission, therefore, is multiplied 50-100 times, making comparison unreliable.

That this is not a hypothetical proposition, I have had frequent opportunities to convince myself. In my work, I have taken all possible precautions to insure a uniform dilution, my method being as follows:

The sample of water is shaken vigorously and 1 c.c. is transferred to a sterile bottle, to which 50 or 100 c.c. of sterile tap water are added. The bottle is then shaken vigorously 50 times, and of this dilution 1 c.c. is transferred directly into the Petri dish, to which the medium is added.

Yet, with all these precautions, I seldom find two plates alike; and while the difference is 10-20 colonies, this number when multiplied 50-100 times makes a total of 500 to 1,000 colonies, which influences the percentage decidedly. On the other hand, if the effluent is diluted the results are often disastrous to the apparent efficiency of the filter, for the reason that with a small number of bacteria in the water equal distribution is well nigh impossible. A single fraction of a c.c. may therefore contain more than an aliquot number of bacteria, and the results multiplied 10-25 times, as the case may be, will give a total number of bacteria far in excess of the number actually present.

Moreover, assuming that all the previous objec-

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TABLE I.—Showing the Relation of Toxigenic* to the Total Number of Bacteria in Both Raw and Effluent of Experimental Slow Sand Filter No. 1.

Date	Raw water: Number of bacteria on Nahrstoff-Heyden agar	Raw water: Number of bacteria on lactose agar Anaerobic at 38° C	Raw water: Percentage relation between the two	Effluent: Number of bacteria on Nahrstoff-Heyden agar	Effluent: Number of bacteria on lactose agar Anaerobic at 38° C	Effluent: Percentage relation between the two
1	21,600	176	0.81	18,000	28	0.15
2	40,000	1,570	3.92	1,200	22	1.83
3	75,000	1,120	1.49	2,000	9	0.45
4	48,000	375	0.78	1,000	23	2.30
5	50,000	100	0.20	1,000	5	0.50
6	45,000	280	0.62	1,300	14	1.06
7	225,000	2,000	8.88	4,200	15	0.35
8	90,000	500	0.55	3,500	4	0.11
9	76,000	175	0.23	4,000	17	0.42
10	14,500	59	0.40	210	8	3.80
11	8,600	41	0.47	4,700	2	0.04
12	120,000	800	0.66	10,500	15	0.14
13	95,300	380	0.39	8,500	14	0.16
14	27,000	130	0.48	2,350	4	0.15
15	66,000	127	0.19	1,400	6	0.42
16	99,800	132	0.13	890	5	0.56
17	87,900	84	0.08	2,200	9	0.40
18	47,500	172	0.36	2,170	21	0.96
19	26,500	723	2.72	1,800	12	0.66
20	140,000	2,400	1.71	1,300	6	0.46
21	54,600	600	1.09	103	11	10.67
22	62,600	184	0.27	4,240	9	0.21
23	31,900	281	0.88	1,630	88	5.39
24	37,200	308	0.82	1,800	29	1.61
25	32,800	6,300	19.20	2,130	64	3.00
26	29,000	370	1.27	4,000	47	1.17

*The term "Toxigenic" first employed by Vaughn in his description of the Michigan Method (Jour. Am. Med. Assn., April 9, 1904) is here used advisedly and for want of a short term to designate the bacteria developing at 38° C. on lactose agar. I have no evidence that these bacteria are toxigenic, but there is no doubt that they include all of the toxigenic bacteria present in the samples. The error of including in this group harmless saprophytes is not likely to be great.

TABLE II.—Number of Bacteria in Raw Water and Effluent of Filters 2 and 3, on Various Culture Media.

Date 1905	Filter No. 2: Agar at 20° C.: Raw water	Agar at 20° C.: Effluent	Agar at 20° C.: Efficiency per cent.	Lactose Agar at 38°: Raw water	Lactose Agar at 38°: Effluent	Bile salt Agar at 38°: Raw water	Bile salt Agar at 38°: Effluent	B. Coli in 1 c.c.: Raw water	B. Coli in 1 c.c.: Effluent	Filter No. 3: Agar at 20° C.: Raw water	Agar at 20° C.: Effluent	Agar at 20° C.: Efficiency per cent.	Lactose Agar at 38°: Raw water	Lactose Agar at 38°: Effluent	Bile salt Agar at 38°: Raw water	Bile salt Agar at 38°: Effluent	B. Coli in 1 c.c.: Raw water	B. Coli in 1 c.c.: Effluent.
1-16										33,900	4,000	88.2	194	52	30	8	+	+
1-17										18,000	300	98.4	200	45	43	4	+	—
1-18										15,700	50	99.7	100	24	17	9	+	—
1-19	Filter out of service during repairs to race									20,000	700	96.5	80	24	33	3	+	—
1-20										18,700	300	98.4	60	24	..	..	+	—
1-21										1,050	50	95.3	100	37	..	..	+	—
1-23										1,000	30	97.0	52	6	6	0	+	—
1-24										2,400	45	98.2	47	10	2	0	+	—
1-25	7,400	400	94.6	472	12	258	3	+	—	19,000	Lost	....	36	12	6	0	+	—
1-26										Lost	Lost	....	26	6	9	0	+	—
1-27										35,000	430	98.8	15	8	8	0	+	—
1-28										4,000	56	98.6	131	6	28	3	+	—
1-30										26,100	200	99.3	63	8	19	0	+	—
1-31										19,000	200	99.0	53	3	12	2	+	—
2- 1										15,000	100	99.0	94	7	10	2	+	—
2- 2	Filter out of service during repairs to race									20,000	93	99.6	94	7	22	0	+	—
2- 3										22,000	145	99.4	40	8	6	0	+	—
2- 4										33,400	84	99.8	111	8	36	0	+	—
2- 6										900	27	97.0	30	12	13	0	+	—
2- 7										1,600	27	98.3	32	9	9	0	+	—
2- 8										10,200	60	99.5	51	8	5	0	+	—
2- 9										12,800	88	99.4	38	4	13	1	+	—
2-10										10,200	100	99.1	42	8	17	0	+	—
2-11										20,300	98	99.6	234	30	40	0	+	—
2-13	8,900	3,500	60	108	215	29	74	+	+	4,300	12	99.7	203	8	25	0	+	—
2-14	31,200	9,700	69	500	300	247	132	+	+	6,800	17	99.8	86	17	45	0	+	—
2-15	21,500	6,900	68	142	150	128	110	+	+	6,900	25	99.8	131	11	50	0	+	—
2-16	12,300	6,150	50	150	89	150	64	+	+	17,500	35	99.8	75	9	29	0	+	—
2-17	3,600	5,000	....	280	73	187	41	+	+	4,300	32	99.3	64	5	23	0	+	—
2-18	5,700	4,200	26.4	367	282	312	148	+	+	4,200	44	99.0	212	18	55	0	+	—
2-20	16,300	2,650	83.8	1,008	209	731	127	+	+	4,100	39	99.1	28	9	13	2	+	—
2-21	1,200	1,125	6.3	63	94	15	56	+	+	1,700	8	99.6	82	14	39	0	+	—
2-22	10,400	400	96.3	1,728	47	....	...	+	+	1,700	17	99.0	38	8	6	0	+	—
2-23	4,300	1,000	76.8	800	94	....	...	+	+	1,000	18	98.2	37	14	0	0	+	—
2-24	2,900	75	97.0	180	34	100	33	+	+	4,200	18	99.6	36	4	19	0	+	—
2-25	13,200	250	98.1	927	38	424	18	+	+	3,400	21	99.4	112	12	34	4	+	—
2-27	44,500	2,700	93.9	230	180	190	70	+	+	2,200	32	98.6	54	11	18	0	+	—
2-28	12,100	1,700	86	93	55	36	11	+	+	5,100	32	99.4	85	8	22	0	+	—
3- 1	12,400	475	96.4	680	66	330	13	+	—	15,000	49	99.7	113	13	28	0	+	—
3- 2	4,500	575	87.3	400	24	111	7	+	+	6,400	29	99.6	150	4	83	0	+	—
3- 3	3,400	25	99.3	108	21	43	1	+	—	5,100	17	99.7	93	11	42	0	+	—
3- 4	Lost	Lost	...	500	70	Lost	Lost	+	+	Lost	Lost	....	204	22	Lost	Lost	+	—
3-11	Filter scraped									Filter scraped								
3-14	26,000	3,900	85.1	2,000	134	1,800	98	+	—	26,700	3,700	86.0	103	76	59	18	+	+
3-15	22,000	5,500	75.0	900	212	900	132	+	+	19,600	3,000	84.7	126	44	58	20	+	+
3-16	20,600	2,200	89.4	1,720	80	1,730	Lost	+	+	5,000	1,700	69.7	122	42	55	10	+	+
3-17	17,000	600	96.5	780	52	766	11	+	—	18,000	1,000	92.9	128	40	34	5	+	—
3-18	17,100	500	97.1	900	53	780	15	+	—	6,200	500	92.0	62	14	49	5	+	—
3-20	58,600	250	99.6	500	41	970	0	+	—	5,100	120	97.9	87	14	18	0	+	—
3-21	42,300	123	99.8	1,000	26	720	0	+	—	7,000	82	99.0	82	31	7	0	+	—
3-22	35,700	166	99.6	460	45	730	4	+	—	19,500	91	99.5	373	17	140	1	+	—
3-23	10,000	68	99.4	330	22	870	0	+	—	13,700	75	99.6	153	19	110	1	+	—
3-24	12,000	90	99.3	3,000	23	2,100	4	+	—	7,700	55	99.4	142	20	208	1	+	—
3-25	9,500	60	99.4	3,000	45	2,500	4	+	—	8,500	83	99.1	600	30	600	1	+	—
3-27	5,700	49	99.2	400	21	150	3	+	—	4,400	63	98.6	200	17	100	0	+	—
3-28	3,000	55	98.2	47	17	7	1	+	—	3,100	75	97.6	40	11	11	0	+	—
3-29	6,700	75	98.9	202	29	244	2	+	—	1,800	103	94.3	41	13	9	0	+	—
3-30	9,000	56	99.4	1,100	23	1,200	8	+	—	4,100	69	98.4	47	14	9	0	+	—
3-31	4,700	65	98.7	129	18	270	3	+	—	1,100	98	91.1	47	14	31	0	+	—
4- 1	8,500	96	98.9	....	...	....	...	+	—	1,500	100	93.4	...	..	..	..	+	—
4- 3	Filter stopped to drain									1,200	65	94.6	19	16	3	0	—	—
4- 4										7,200	66	99.1	23	11	9	1	—	—
4- 5										1,200	97	92.0	15	8	4	0	—	—
4- 6										5,500	118	97.9	Discontinued		37	2	—	—
4- 7										3,000	128	95.8			40	0	+	—
4- 8	Filter scraped									4,100	94	97.8			..	..	+	—
4-10	5,600	425	92.5	Discontinued		96	16	+	—	1,700	83	95.2			51	3	—	—
4-11	46,300	1,000	97.9			1,600	1	+	—	400	73	81.8			27	0	+	—
4-12	25,800	650	97.5			1,400	31	+	+	1,900	83	95.7			30	0	+	—
4-13	7,100	126	98.3			634	9	+	—	2,350	82	96.6			25	1	+	—
4-15	6,500	92	98.6			234	2	+	—	900	54	94			69	0	+	—
4-17	1,400	68	95.8			4	0	+	—	10,500	37	99.7			3	0	—	—
4-18	5,400	39	98.6			26	0	+	—	1,600	58	96.4			2	1	+	—
4-19	9,000	92	99.0			10	0	+	—	1,800	39	97.9			23	0	—	—
4-20	18,700	99	99.5			15	0	+	—	2,400	77	96.8			2	0	+	—
4-21	56,400	69	99.9			42	0	+	—	3,500	36	99			6	0	+	—
4-22	67,200	162	99.8			101	0	+	—	5,800	41	99.7			9	1	+	—
4-24	75,400	92	99.9			600	0	+	—	3,900	63	98.4			2	0	+	—
4-25	13,300	36	99.8			90	0	+	—	1,700	56	96.8			18	0	+	—
4-26	15,100	29	99.9			500	0	+	—	1,100	29	98.2			7	0	+	—
4-27	53,200	31	99.9			2,000	0	+	—	2,500	21	99.2			3	0	+	—
4-28	41,000	40	99.9			1,200	0	+	—	3,400	13	99.7			11	0	+	—
4-29	18,200	27	99.9			200	1	+	—	5,400	28	99.5			54	0	+	—
5- 1	23,200	75	99.7			204	1	+	—	2,300	31	98.7			13	0	+	—
5- 2	10,300	143	98.7			26	2	+	—	7,100	19	99.8			11	0	+	—
5- 3	8,900	330	96.4			102	1	+	—	6,700	38	99.5			4	0	+	—
5- 4	18,600	34	99.9			81	0	+	—	2,800	33	98.9			1	0	+	—
5- 5	18,200	92	99.5			127	0	+	—	2,700	26	99.1			12	0	+	—
5- 6	8,500	108	98.8			380	0	+	—	3,600	19	99.5			17	0	+	—
5- 8	9,000	94	99			200	0	+	—	3,000	49	98.4			25	0	+	—
5- 9	5,700	49	99.2			178	0	+	—	1,325	12	99.1			61	0	+	—
5-10	3,200	61	98.1			145	1	+	—	600	26	95.7			12	1	+	—
5-11	10,300	32	99.7			139	0	+	—	600	17	97.2			11	0	+	—
5-12	11,300	167	98.6			174	0	+	—	1,100	15	98.7			14	0	—	—
5-13	9,600	90	99.1			350	0	+	—	425	23	94.6			22	2	+	—

tions could be successfully removed, there still remains the inherent weakness in the fact that neither gelatin nor agar gives us the desired information promptly enough for practical purposes. If the records of efficiencies of filters are merely to serve the purpose of registering past efficiencies, then it does not matter whether 2, 3, 4 or more days elapse from the time the plates are made to the time of counting. On the other hand, if the tests are for the purpose of showing from day to day how each filter bed is working, then the information obtained 3 to 4 days later is practically worthless.

Assuming that something has happened to one of the filter beds, and the raw water passes through it unfiltered, it will take at least two days to discover the inefficiency of this bed. In the meantime 5 to 6 million gallons of unfiltered or improperly filtered water passed into the mains.

What may happen to one bed may happen to more than one without the danger being discovered for 2 to 3 days. This last objection alone seems to me of sufficient importance to condemn the present method of testing large filters.

To sum up the objections:

(1) We have no evidence to show that the bacterial species in the effluent are the same as in the raw water at the time the samples are collected. On the contrary, there is probably a more or less independent bacterial flora in each.

(2) Neither agar nor gelatin brings out all of the bacterial species present in the water, and while certain species in the raw water may develop, others in the effluent may not, and thus the correspondence between the two counts may be materially disturbed.

(3) The efficiency of a filter as expressed in percentages means nothing so long as the percentage depends on the variable number of bacteria in the raw water from day to day; the percentage efficiency may be very high and yet the effluent may be bad, and vice versa.

(4) The usual method of testing the efficiency of a filter does not give the information soon enough so that the operations of the filter may be watched from day to day. It is, therefore, of no practical value in cases of sudden and unsuspected accidental disturbances.

THE EMPLOYMENT OF RESTRAINING MEDIA.

There is no doubt that sanitary bacteriologists and engineers have felt all along that the method they employ in testing the efficiency of a filter is unsatisfactory, to say the least. This is evident from repeated attempts on their part to establish a more or less fixed limit to the number of bacteria admissible in the effluent. Some adopt the German standard of 100, while others make the standard 70 or less, depending somewhat on the general quality of the raw water.

The objection to this arbitrary standard has already been explained. So long as this standard includes saprophytic organisms it is difficult, if not impossible, to establish a fixed standard without at the same time specifying minutely the method and manner of preparation of the media, the kind of media as well as the conditions of cultivation.

Again, to the layman a percentage of 99 or 99.9 is somehow more intelligible than a certain number. He understands when you tell him that "the water is 99% pure," but when you say that it contains 40 or 70 bacteria in each 15 drops, he may reasonably ask what these bacteria are. It is perhaps for this if no other reason that filtration engineers perfer to express the efficiency of a filter in percentages.

As already stated, the effluent of a filter is to be looked upon as an underground water, the bacterial purity of which depends (1) on the efficiency of the purification of the surface water as it filters through the ground, and (2) the ability of this pure water to maintain bacterial life. The acci-

dental contamination of this underground supply is, of course, another important but inconstant factor, determining the purity of the water. If we exclude the saprophytic bacteria as of no practical importance, we then deal principally with bacteria which represent species found in sewage and in surface water contaminated with sewage. These bacteria should be absent from a pure underground water, and should also be absent from the pure effluent of a sand filter.

To exclude the saprophytic bacteria from our counts we may employ the following means:

(1) High temperature (38° C.) which inhibits the growth of the majority of ordinary water bacteria.

(2) Various restraining media.

High temperature alone is not sufficient, as quite a number of ordinary water bacteria may develop at body temperature. It may be rendered more efficient when combined with the effect of such a medium as lactose agar, especially if grown anaerobically.

Restraining media, or media containing small amounts of antiseptics, have been found by experience to be the best means of inhibiting the development of ordinary water bacteria.

In my work on experimental slow sand filters, I have employed for a long time lactose agar (1%) grown at 38° C. The number of bacteria which are capable of developing on this medium as compared with the number of bacteria which develop on Nahrstoff-Heyden agar is shown in Table I. The relation of the number of these bacteria in the effluent to the same in the raw water may be seen by referring to Table II. Satisfactory as this medium proved to be in a general way, its action was not uniform enough. It was apparent that despite the vigorous environment, quite a number of saprophytic bacteria develop now and then.

The use of carbolic acid lactose agar (0.1%) was soon abandoned, as the medium proved too rigorous even for B. Coli, when present in small numbers.

The medium which suggested itself as the one best adapted to the purpose of limiting the development to a very few species, principally intestinal bacteria, is MacConkey's bile-salt medium, which consists of:

Agar	1.5 grms.
Sodium taurocholate	.5 "
Peptone	2.0 "
Water	100 c. c.

This is prepared as usual and then 1% lactose added, and the medium is tubed and sterilized for three successive days.* Plates are made with 1 c. c. of water and incubated at 38° C. for 18 hours.

Originally this medium was intended to serve for the differentiation of B. Coli. from B. typhosus, the claim being that the colonies of the respective organisms show characteristic differences. So far as I know, it has never been used in the examination of waters or in testing filters. Yet, the nature of this medium seems to be such as would render it highly useful for work of this character.

It has been frequently observed that while faeces is seen to contain large numbers of bacteria when examined directly through the microscope, a comparatively small number can be cultivated, and those capable of cultivation belong to a few well-defined species. This would seem to indicate that the majority of bacteria which enter the gastro-intestinal tract are destroyed during their passage. There is reason to believe that one of the most important antiseptic agents in the intestinal tract is bile, which owes its antiseptic action to its salts, sodium and potassium taurocholate.

However, while the majority of bacteria ordinarily found in food, air and water, are destroyed by the bile salts, the comparatively few species of what are known as intestinal bacteria seem to be capable of withstanding the effect of these salts, thus escaping uninjured with the faeces. It is therefore reasonable to suppose that a culture medium containing bile salts will restrain the development of all but the few intestinal bacteria, or bacteria which possess an equal resistance. Of the latter probably a very limited number of species is found outside the intestinal tract. The experimental work carried on with this medium convinced me that these suppositions are correct.

The material for this work was furnished by two slow sand experimental filters made of terra cotta pipes, each 3 ft. in diameter and 9 ft. high. The arrangement of the interior of each filter was as follows: The bottom was constructed of cement about 6 ins. deep. On this bottom there are several rows of bricks set on edge, about 6 ins. apart, supporting a floor of bricks laid flat. The opening of the effluent pipe communicates with this underdrain. This brick floor supports the filter bed, which consists of 3 ins. of pea gravel, 1 in. of coarse sand, and 3 ft. of fine sand (effective size 0.29 mm., uniformity coefficient 1.6). On the top of the sand there is about 4 ft. of water. The water for Filter 2 is obtained directly from the creek, while that for Filter 3 comes from the city reservoir, after having from 2 to 3 days sedimentation. Both filters communicate by means of a pipe connected with the underdrain, the object being to refill each with filtered water, after scraping. At all other times the connection is closed.

The rate has been 3,000,000 gallons per acre, maintained uniformly by a float valve device gotten up by Mr. E. R. Mack, one of the engineers of the department. The results obtained on various media for a period of three months are shown in Table II., which establishes conclusively the value of bile-salt agar as a test of the hygienic efficiency of a filter. These two filters had been in operation for three months before we commenced the use of bile-salt agar in connection with the other media. During the process of "ripening" the efficiency of both was low. The bacterial efficiency became established in January, when Filter 3 was scraped on the 8th, while Filter 2 was thrown out of service, owing to repairs on the race. The gradual improvement of Filter 3 following the scraping is shown on all the media, but more particularly on the bile-salt agar. It is seen that irrespective of the number of bacteria in the raw water, as shown on the bile-salt agar, the number in the effluent at no time during this period exceeded four, and these, as was evident from an examination of the colonies, belonged to one species. Filter 2, which has been at rest for a month, shows a considerable number of colonies on bile-salt agar, even when the bacterial efficiency on agar at times reached 97 to 98%. On March 11 both filters were scraped and had to be filled up from below with raw water from the reservoir. This caused a marked disturbance in the efficiency of the filters, the effect being best shown on the bile-salt agar. At the end of the first week Filter 3 returned to its normal efficiency, which it has maintained ever since.

Yet, while the efficiency as shown on bile-salt agar has been uniformly excellent, the efficiency as shown on plain agar has been rather poor, and the percentage has on several occasions fallen to below 95, owing to the low number of bacteria in the raw water, as well as the relatively high numbers in the effluent. Of course, in the light of the bile agar counts, these low efficiencies mean nothing, but without the bile-salt agar they would cast a doubt on the high efficiency that filter has maintained, and also introduce a disturbing factor into the average.

Filter 2 has not shown the same efficiency as Filter 3. It is receiving the water as it comes from the creek, which is very often muddy, and on that account must be scraped about every three weeks. These frequent disturbances act deleteriously on the hygienic efficiency of the filter, as is shown by the bile-salt agar counts.

It is quite evident that there are but comparatively few species capable of developing on bile-salt agar, and these include the sewage organisms as well as the typhoid bacillus. By thus restricting the number of species which would develop on the medium, we establish by a routine method what may be determined by applying known bacteria, as B. prodigiousus, to the filter. In other words, we determine the hygienic efficiency of the filter.

What the species of bacteria developing on bile-salt agar actually are we have not as yet determined in a systematic manner. A number of the colonies isolated from the plates made from the effluent proved not to be typical B. Coli, some of them seemed to belong to B. subtilis, and once micrococcus simplex was isolated.

Systematic determination of species is a difficult task, and I am taking up this part of the problem as a separate investigation. However, for practical purposes, we need not go to the length of species determination in each case. What is wanted is a general standard or a permissible limit to the number of bacteria per 1 c. c. This standard must be established in each locality, in the same manner as the chlorine standard is or should be established. Wherever a filtration plant is either planned or in operation a small experimental filter, placed under the best conditions and operated with the greatest care, should be employed as a means of establishing this standard. Such a filter operated for a year or more, to take in the seasonal variations, will enable the bacteriologist in charge to establish the maximum number of colonies on bile-salt agar consistent with high efficiency. If this number be five, then any number very much above that would be a cause of suspicion and would indicate the advisability of an investigation.

Of course, no claim is made that this work is complete. Future investigations will no doubt elucidate many points which are as yet doubtful. These investigations should include the determination of the species which develop on bile-salt agar as well as whether bacteria capable of developing on this medium are to be found in waters from various sources. On this point we found that water from a very pure spring, showing only 4 colonies on gelatin, showed none on bile agar. Well water, showing 70 colonies on agar, showed 2 on bile agar, while B. Coli. was absent. Raw city sewage, when plated on bile agar, showed from 18,000 to 27,000 colonies per c. c.

The general conclusions which seems to be warranted at this time are:

(1) By the use of restraining media we are able to determine the hygienic efficiency of a filter.

(2) Bile-salt agar seems to be best adapted for this purpose, as it limits the development to a very few species which include sewage organisms.

(3) The results obtained on this medium furnish more important information than the fanciful percentage efficiencies.

(4) This information may be obtained in 18 hours, a point of prime importance in the matter of operating sand filters.

*The formula and method of preparation of the bile-salt media are given in Muir and Ritchie's Manual of Bacteriology, edited by Harris, and Eyre's Bacteriological Technique.

RECREATION BUILDINGS FOR THE SOUTH PARK SYSTEM, CHICAGO, ILL.

The South Park System of Chicago, Ill., has, during the past two years, purchased numerous sites for small parks in the thickly populated sections of the south side of that city for the purpose of affording those of the people living a considerable distance from the larger parks more frequent opportunities for recreation and outdoor amusements. An essential feature of the plan is to construct at these small parks recreation buildings, field houses or neighborhood assembly buildings, consisting of a main or assembly hall building, men's and women's gymnasiums, plunges, swimming pools, wading pools for children and their necessary appurtenances in the way of power plant, laundry, dressing rooms, lockers, etc. Contracts for a dozen or more of these buildings have already been let and some seven or eight of them have been completed. The construction is almost entirely of concrete, the foundations, tanks, walls, conduits, partitions, lockers, etc., being of this material; only the roof is of timber and this is shingled with roofing tile.

DESCRIPTION OF STRUCTURE.—The drawings and views constituting Figs. 1 to 7 show

the construction of the building at Park No. 3. The same general design and construction was adopted for all the other buildings. Fig. 1 is a first floor plan. As will be seen, the structure consists of two buildings which, with the connecting pergolas inclose an area 180 ft. square with a court in the center to provide for a swimming pool. The lay-out of the several parts of the buildings is clearly shown by the plans and need not be described in further detail, except to note the conduit provided as shown in the foundation plan, Fig. 2, for the steam and water pipes and other service lines, and also to show the construction of the swimming pool as indicated in the drawings of Fig. 3.

Architecturally the building is noteworthy for the pleasing effects secured from the concrete in plain wall finish, moldings and ornaments. With the exception of the caps and bases of pilasters, keystones and rosettes, which were cast separately in plaster molds and set in place like cut stone, all the ornamental effects, such as water table projection, sills and caps, cornice and low relief work on the upper portion of the wall, were produced by attaching suitable negatives to the inside of the wall forms. No portion of the walls were plastered or otherwise dressed; the walls stand in respect to surface finish just as they come from the forms. Figs. 4 and 5 show clearly the excellent surface appearance secured.

METHOD OF CONSTRUCTION.—The concrete walls were constructed by means of forms continuous from the footings to the roof. The views Figs. 6 and 7 show the construction of the forms and staging that supported them. The forms proper were made of 2 × 10-in. dressed and matched lumber and were built upward in sections 4½ ft. high. The main verticals of the staging were 6 × 6-in. timbers braced together and from the ground, as is clearly shown by the views. It will be noticed that the staging is so arranged that a clear working space is provided for erecting the wall forms and placing the concrete.

The concrete used was composed of 1 part Vulcanite Portland cement, 2 parts limestone screenings free from dust, and 4 parts mixture of ¼-in. crushed stone and ½-in. crushed stone. This concrete mixture was found after numerous experiments to give best the uniformity of color and density sought for by the builders. The concrete was mixed fairly dry, only sufficient water being used to permit of thoroughly tamping the mixture without causing the mortar to ooze or run down in streaks. No plastering was done nor was a facing coat of mortar used. All the concrete for the first story of the building was wheeled up runways, but that for the second story was hoisted at the center of the building.

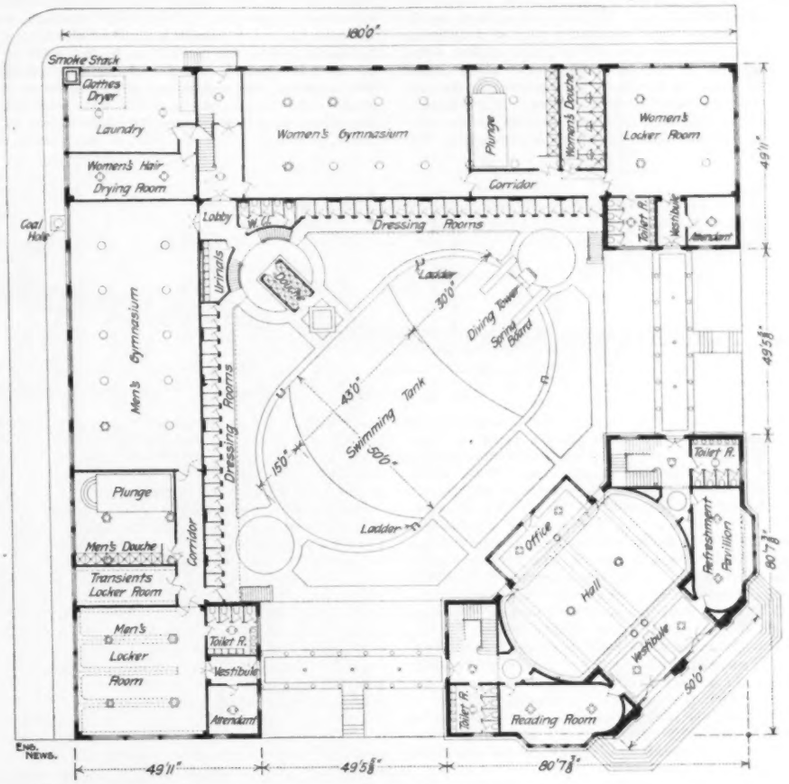


FIG. 1. GROUND PLAN OF RECREATION BUILDING, SOUTH PARK SYSTEM, CHICAGO, ILL.

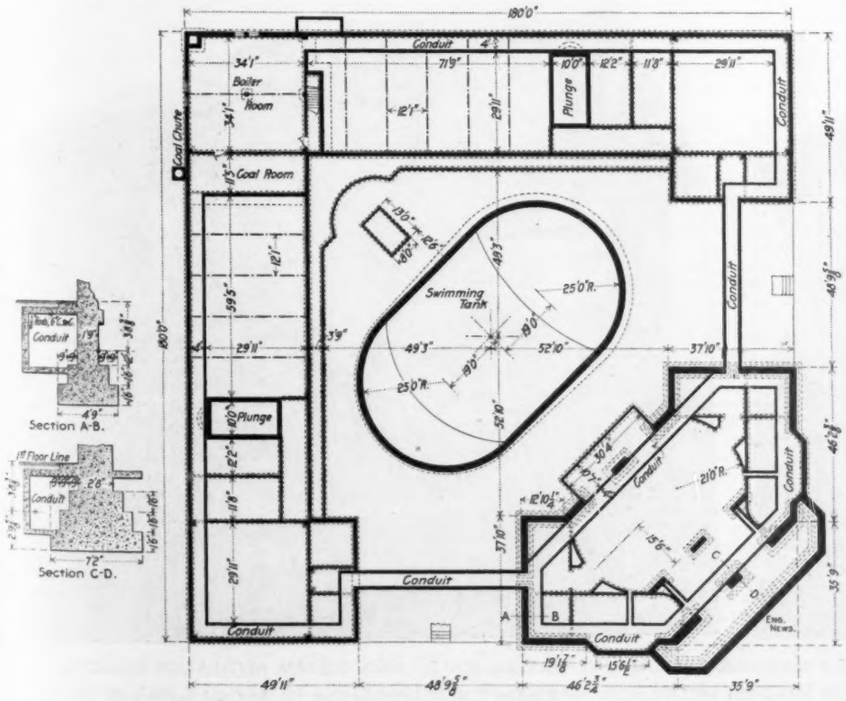


FIG. 2. BASEMENT PLAN OF SOUTH PARK SYSTEM, RECREATION BUILDING.

The contractors for the work were Rudolph S. Blome & Co., of Chicago, Ill., and we are indebted to them for the information from which this description has been prepared.

THE PREVENTION OF STOPPAGES IN GAS SERVICES, METERS AND HOUSE PIPES DURING COLD WEATHER.*

By Irvin Butterworth.†

The majority of the cities in which the gas companies represented in this association do business are located in the northern half of the United States, where the winters are so long and severe that much trouble is experienced from the stoppage of service pipes, meters and house pipes by deposits of frost and water condensed out of the gas. This is particularly true of the most northern cities; and with the exception of those in the extreme south, none of the companies are entirely exempt from this trouble. In this paper I wish in the first place to point out the seriousness of this imperfection in the gas business of to-day, and in the second place to mention and comment upon some of the remedial measures that have been proposed for its relief, or that have already been applied thereto with more or less success in European countries.

It is my firm conviction that the time has gone by when a gas manager can afford to content himself with following the methods now in vogue in this country for treating the routine difficulties incident to the distribution of gas in extremely cold weather. It no longer should suffice, nor indeed does it suffice, for a gas company to resignedly and complacently assure its consumer who suddenly finds his supply of gas cut off, say in the early hours of a long winter evening, by an insidious and unsuspected deposit of frost in his service pipe, that such an interruption is now and then unavoidable in the gas business, that there is no way of preventing an occasional stoppage of this kind, and that a man will soon be out to free his service pipe of the obstruction and restore the flow of gas. I feel so strongly on this subject that I regard it as nothing short of an actual calamity for a gas company to have even one of its consumers thus suddenly deprived of his supply of gas on a single occasion.

The manufacture and distribution of gas have been carried on as a business for a hundred years, and the thinking layman, in this age of mechanical progress and refinement in other long established industries, expects, and has a right to expect, that by this time surely, gas

*Abstract of a paper and discussion before the Western Gas Association, Chicago, Ill., May 17, 1905.
†Grand Rapids, Mich.

men have devised means and methods for insuring the continuity of the gas supply at his premises in winter as well as in summer. And yet during three months of the winter of 1903-4 in the little city of Grand Rapids, where the distribution of gas is accomplished along rather better lines than the prevailing good practice of the day, most of the service pipes being boxed in tar concrete, there were 3,000 individual interruptions of the gas supply due to frost and water in the pipes and meters. Detroit had relatively as many, and if the companies in other cities should make an honest confession, the disclosures by each of them would be equally discreditable to the gas business in these modern times. I am aware that the winter mentioned was exceptional in the severity and persistency of its cold weather; but the inconvenience, discomfort and distress, not to say the actual damage, that gas companies cause their consumers, even in average winters, by their failure to provide some pure preventive of these interruptions, are a sad commentary on either their engineering skill or their business judgment.

Let us now see what choice of such measure we may have, and discuss briefly their relative merits. I will consider the following seven methods, some of which have been tried, while others as yet, have been only proposed: (1) Drying the gas by washing with sulphuric acid; (2) exposure to calcium chloride; (3) to quicklime; (4) to calcium carbide; (5) compression; (6) air condensation in overground pipes or air condensers; (7) reduction of freezing point of vapors contained in the gas by the admixture of alcohol vapor.

It will be observed that all of these methods contemplate some treatment or manipulation of all of the gas as it passes from the holder outlet into the street mains, and that the first six contemplate the removal from the gas of the water vapor contained therein, at least such portion of it as will render the remaining moisture insufficient to cause any trouble; for it is said to have been found, according to Dr. Harrop, that 0.6% of water vapor can be safely left in the gas, this being half of a total of 1.2%, which is about the quantity that saturated gas contains as it leaves the holder under average pressure conditions and at a temperature of, say, 50° F., or about 12 cu. ft. of water vapor for each 1,000 ft. of gas. I would feel that it would be safer, however, especially in extremely cold weather, to remove practically all of the water vapor from the gas, if this can be economically accomplished. Obviously, if the water vapor be removed there will be no stoppages from frost or water, and an incidental benefit which must not be lost sight of would be the prolonging of the life of our meter diaphragms which, as is well known, are greatly injured by condensation in the meters, especially when such condensation is not of an oily nature. The chief object to be attained, of course, is the prevention of stoppages caused by cold weather, and such being the case, any method employed for this purpose need not be operated except during the two or three coldest winter months; but there is not much condensation in meters during the other months of the year in any event. Furthermore, it is generally recognized among gas men that the moisture in the gas favors the deposition of naphthaline, and so by drying the gas we "kill two birds with one stone," getting rid of stoppages from both naphthaline and frost. To my mind, therefore, some method of desiccating the gas would be preferable, if a feasible and economical one could be found, to method No. 7 (the introduction of alcohol vapor), which leaves all the moisture in the gas, allowing it to condense in the pipes and meters and only aiming to so lower its freezing point that it will not congeal. I confess, however, that method No. 7 is the only one that is at present in successful use, notwithstanding the fact that the desirability of distributing desiccated gas has long been recognized, the American Gas Light Association having discussed this question as long ago as 1872. Let us consider the foregoing methods in the order given (we have omitted the descriptions of the methods which the author does not consider practicable—Ed.):

DRYING BY EXPOSURE TO QUICKLIME.—This method would be similar to the preceding and probably much more economical, but I cannot find that it has ever been tried on a large scale. From data furnished me by Dr. Harrop, I calculate that with gas at 50° F. 1 lb. of freshly burned lime per 1,000 cu. ft. would suffice if the gas were properly exposed to it, to reduce its moisture content to 0.6%. A portion of this lime, equivalent to about 0.4 ct. a lb. per 1,000 cu. ft. of gas treated, could be afterwards utilized in the ammonia concentrator, leaving the net quantity of lime chargeable to the desiccation of the gas about 0.6 lb. per 1,000 cu. ft., costing say about 0.2 ct. Or if enough lime were used to practically completely desiccate the gas, which would be preferable, it would cost twice this much, or say, ½ ct. per 1,000 cu. ft. While the first cost of the lime itself would, then, not be excessive, this method might nevertheless not be as economical as some of the others under consideration on account of the first cost of the necessary apparatus and the cost of handling the material.

DRYING BY AIR CONDENSATION IN OVERGROUND PIPES OR AIR CONDENSERS.—This method of desiccating artificial gas has not, to my knowledge, yet been tried on a large scale, although it is successfully employed by some natural gas companies in removing the entrained water from natural gas. (See American Gas Light Journal of Nov. 21, 1904, page 802.) Although the problem of its application to artificial gas is much complicated by the danger of condensing out the illuminants as well as the water vapor, I confess that this method appeals to me as offering great and promising possibilities. No machinery or chemical agencies are needed, and very inexpensive apparatus can be employed, while the labor cost would be extremely small. All that is required is a system of pipes laid above but not directly upon the ground, or almost any other sort of large air condenser, connected by means of valves with the holder outlet in such a manner that in cold weather the gas could be passed through this condenser, thus subjecting it to air condensation, the amount of exposure being varied by means of valves according to the fluctuations in the temperature of the air, and at no time cooling the gas to a lower temperature than it would reach in any event in passing through the mains and consumers' services. In this way there would be no greater loss of candle power than would occur if the device were not in use. In fact, we could err on the safe side by not chilling the gas below the temperature that it would reach in the warmest service in the city, and still free it of enough of its moisture to secure us, in my opinion, immunity from the frost and condensation troubles that now make the life of a gas man miserable in cold weather. With one intelligent man in charge of this air condenser, it could be manipulated with absolute nicety, producing exact and ideal results if such were necessary. But, in my opinion, the apparatus would do its work sufficiently well for all practical purposes without painfully close watching or micrometer regulation. It would only be

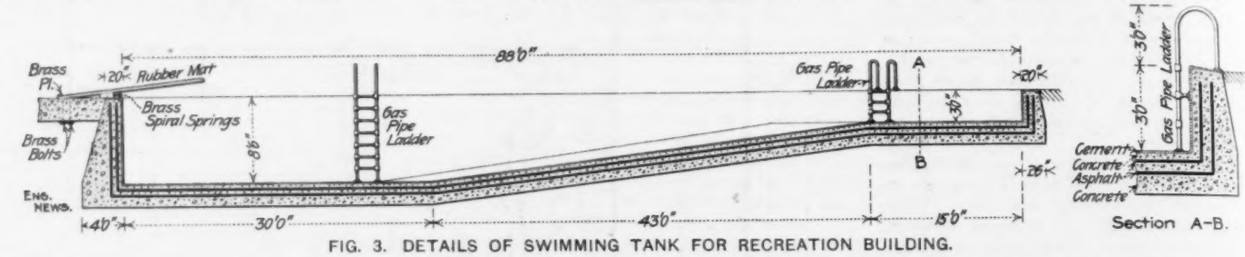
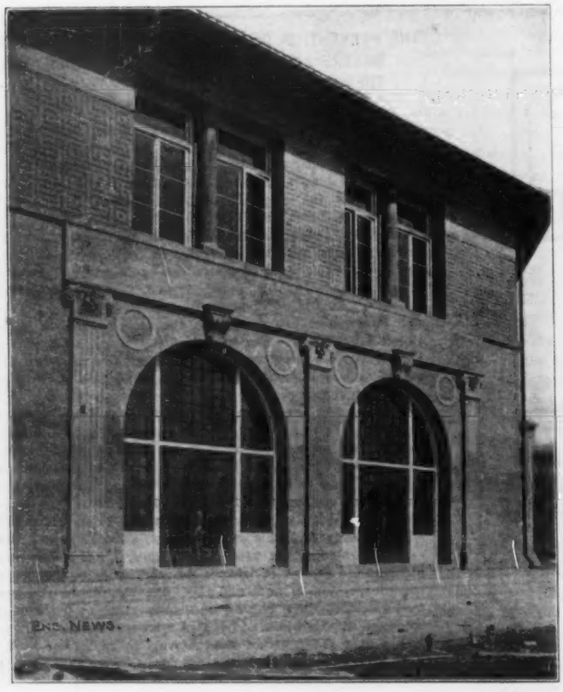


FIG. 3. DETAILS OF SWIMMING TANK FOR RECREATION BUILDING.



FIGS. 4 AND 5. VIEWS SHOWING SURFACE FINISH AND WALL ORNAMENTATION, SOUTH PARK SYSTEM, RECREATION BUILDING.

necessary not to chill the gas below the temperature that it would reach in the warmest services, and as our troubles from frost and condensation would probably disappear before this point should be reached, the range of temperature fluctuation produced by the apparatus could range over quite wide limits. It would probably be necessary to provide duplicate condensers, in order that the plant might be alternately by-passed to permit the removal, by steam, air or other means, of the frost that would deposit in them from the moisture in the gas.

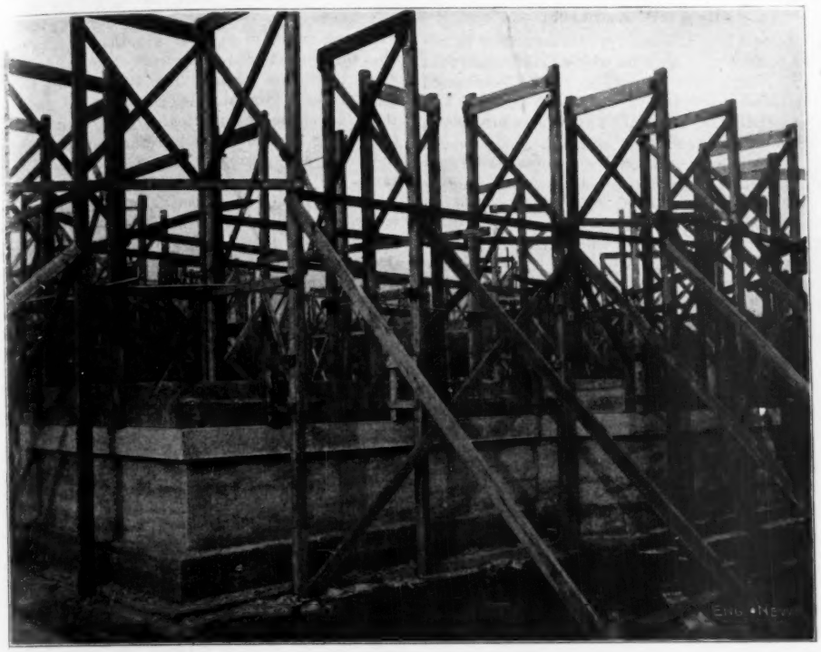


FIG. 6. VIEW OF STAGING AND FORMS FOR CONCRETE WALLS, SOUTH PARK SYSTEM, RECREATION BUILDING.

A conviction of the probable efficacy of this method is forced upon us by well-known experiences of many gas companies. The St. Paul Gas Light Co., during the winter of 1903-4, had much less trouble than usual from freeze-offs, when the opposite experience would naturally have been expected, simply because the weather was so very cold that the quantity of moisture in the gas as it left the holder was in the first place less than usual, and in the second place was nearly all condensed out before the gas reached the consumers' services. In Detroit, during the same winter, there was a system of partially overhead small distribution pipes running to and through various buildings at the gas works. Some parts of these pipes kept continually freezing up until a large iron vessel, made out of a 16-in. gas pipe, which acted as an air condenser, was installed in the main feeder of this system as it emerged from the ground, and immediately the freezing ceased, the moisture, or enough of it, being thus removed. The United Gas Improvement Companies have for years been in the habit of enlarging their lamp post risers where they leave the ground, the enlarged portion serving as an air condenser and thus practically preventing all freeze-offs. In Grand Rapids about one-fourth of the gas consumers live on the west side of the Grand River, the remaining three-fourths being on the east side, where the works are located. The west side consumers are supplied through pipes supported where they cross the river on bridges some 600 ft. long. An examination of our complaint book shows that on the east side of the river there were, during the three coldest months of the winter of 1903-4, six times as many stoppages from frost and condensation per 100 meters as there were on the west side, the difference being wholly due to the exposure of the gas supplied to the west side, to the cooling effect of the air as the gas passed through the pipes on the bridges, as other conditions were the same throughout the city. The proposed air condenser at the holder outlet would merely perform this desiccating function for the gas supply of the entire city, only it would do it more thoroughly and with more safety to the candle power, being at all times under full and easy control. It would be used, as I have said, only in extreme weather, being by-passed or artificially cooled during the warm hours of mild winter days and put into use again as the evening coolness and hours of maximum consumption came on. To my mind, this is the most promising desiccating method of preventing troubles from frost and condensation.

THE REDUCTION OF FREEZING POINT OF CONTAINED VAPORS BY ADMIXTURE OF ALCOHOL VAPOR.—This is the only method that does not involve the desiccation of the gas; and furthermore and unfortunately, it is the only method that is now in successful use. In fact, as far as I know, it is the only method that is now being tried, either successfully or unsuccessfully. It is fully described and illustrated in the American Gas Light Journal, June 15, 1896, page 906. It is the invention of Dr. Bueb, Chemist of the German and Continental Gas Co., of Dessau, Germany, and has, I understand, been patented in this country. It is a scheme and apparatus for introducing into the gas as it enters the street mains from the holders the vapor of wood alcohol, which so lowers the freezing point of the water and other congealable vapors contained in the gas, including benzol, that they do not deposit in the pipes as frost or otherwise. The apparatus is very simple and inexpensive, and consists of an elevated tank containing the alcohol, a regulator for controlling the rate of flow of the alcohol into the vaporizer, a vaporizer for volatilizing the alcohol either by steam or dry heat, and a pipe leading thence in the holder outlet. For temperatures down to 14° F. about ⅛ of a pint of alcohol is necessary per 1,000 ft. of gas, and for temperatures between 14° F. and, say, 6° F., about half a pint is necessary.

As early as 1896, 29 gas works in Continental Europe, principally in Germany, were using this method, introducing the vapor during only the hours of evening consumption; and from an advertisement in the German Gas Journal of December 3, 1904, I notice that the method is now being used in no less than 193 different cities. I also have recent letters from Dr. Bueb's associate, William von Oechelhaeuser, of the gas works at Dessau, Germany, who assures me that the method is very successful and is being extensively adopted and used in Europe. This somewhat surprises me, on account of the high cost of the alcohol used, but Mr. von Oechelhaeuser explains that because of the absence of duty charges the cost of the alcohol in Germany is not prohibitory, as it would almost be in this country. For instance, at 60 cts. per gallon, the present price of wood alcohol in Grand Rapids, ⅛ of a pint, or enough per 1,000 cu. ft. of gas treated to prevent stoppages at 14° F., or over, would cost 2½ cts., while ⅛ of a pint, or enough per 1,000 ft. to prevent stoppages at temperature between 14° F., and 6° F., would cost 3¾ cts. With our present output at Grand Rapids, even if we should use this method during only the three hours of maximum consumption, the cost in below zero weather would be about $30 per day, and, as a matter of fact, on account of the extensive use of gas during the day time, it might be necessary, after all, to vaporize the alcohol during, say, 12 hours out of 24, which would make the cost about $65 per day. Of course, we would save the cost of the alcohol and labor now employed in freeing service pipes in the usual way, and would prevent the annoyance of our customers, which is the chief object to be attained; but this saving and result should, of course, be credited to each of the methods which we have been considering. We have experimented with this method in Grand Rapids during the past winter, vaporizing in the holder outlet, during a portion of our coldest weather, ½ pint of wood alcohol per 1,000 ft. of gas passing through it, with the result that we effected a very marked decrease in the number of freeze-offs; and we should probably have eliminated them altogether had we not been obliged to put our make of gas, during the hours of heaviest consumption, directly into the street mains, by-passing the holder. This gas, not having had the benefit of holder condensation, contained an excessive and abnormal percentage of water vapor, for the complete control of which the quantity of alcohol used was apparently insufficient.

Because of the fact that the gas enters the holder at a uniform rate throughout the 24 hours, but leaves it at widely varying rates, it seems that the proper location for the desiccating apparatus, whichever kind should be employed, would theoretically be on the holder inlet, rather than on the outlet, as much smaller, and therefore less expensive, apparatus would thus be required. In this event, however, it would be necessary to keep the water in the holder tank covered with some kind of oil that would prevent the absorption of water vapor by the dried gas. Although this could probably be successfully accomplished, I have treated this subject on the assumption that the apparatus would be placed on the holder outlet.

If I have made no error in the foregoing calculations, it seems probable that the quicklime method would be much cheaper than the alcohol method that has evidently obtained so strong a foothold in Europe. But, in my opinion, the air condensation method would be the cheapest of all, both in first cost and in operation. While my investigations and experiments have not yet gone sufficiently far to warrant my stating this as a definite and positive conclusion, it is at least evident, I think, from the foregoing discussion of some of the available and feasible methods of prevention, that gas companies should no longer jeopardize their own and their consumers' interests by following the present ancient and ineffective methods on the plea that there is nothing better.

DISCUSSION.

Mr. McAdam—Respecting Mr. Butterworth's remark that "The difference being wholly due to the exposure of the gas supplied to the west side to the cooling effect of the air as the gas passed through the pipes on the bridges, as other conditions were the same throughout the city." I would like to ask him if any provision was made for taking care of stoppages in these bridge pipes by putting alcohol in them. The reason I want to know is that I think an excessive use of alcohol on these bridge pipes would have a tendency to saturate the gas to such an extent that it would prevent stoppages.

Mr. Elbert—In following out any of the various schemes, as suggested for arresting the aqueous vapor, it looks to

Fig. 7. View Showing Forms and Concreting Process, South Park System, Recreation Buildings.

me as if it is shifting one of the troubles properly belonging to the distribution department to the manufacturing end of the business. This, however, might be a move in the right direction, if the sugested remedies will perfect an ideal preventative for the depositing of frost or condensation in the service pipe. I am of the opinion, however, it would not be an entire success. I refer more

particularly to the drying by air in overground condensers. This is an old [illegible] vapor can be removed from the gas by adding ammonia to the gas [illegible] the object of this precipitation. This [illegible] sufficiently large surface to take care of the [illegible] lost. This accomplished, and the vapor, reduced to water, freezes and must be removed again by heat, which at once spoils the effect of the condensing apparatus. At St. Paul we supply a large proportion of our consumers in the east and west districts through mains crossing on bridges. There are practically no frost cases in this territory, but the bridge pipes require constant attention during winter, and we are obliged to flush them with hot, salt water, pumping the same from the drips. This system or something similar no doubt would have to be applied to the air condenser at the works, and as stated above, spoils the effect desired. Again, I cannot see the use of doctoring all the gas with the danger of reducing the candle power, when only a small per cent. of the consumers are ever troubled with frost. Our company, from Dec. 1, 1904, to May 1, 1905, which covers all our frost cases for a year, had 2,714 complaints. A large number of these were duplicated, many times from one customer. Assuming, however, these complaints represented individual consumers, and comparing them with the total number, we would average about one complaint to 5½ consumers for the year, or each consumer requiring attention once in 5½ years, and owing to our latitude I do not believe any gas company would have any more than this. This does not look to me as being an "actual calamity" in failing to supply, partly or wholly, a consumer once in five years. The electric light, telephone or water companies cannot boast of better service. If the average service does not freeze, why should any of them? The laying of a service in tar concrete as at Grand Rapids, is, no doubt, a good preservative to the pipe, but by no means a non-conductor of frost; on the contrary, is one of the best, as frost penetrates through a compact mass and remains longer than in a loose or disintegrated covering. The laying of a service at a great depth is but little better than a moderate covering, and will not remedy the frost trouble entirely, whether a winter is severe or not, and as a remedy I would say a service should never be less than 1¼-in. or larger, and when necessity occasions, should be laid in the center of a wooden box or tube large enough to form a dead air space, with the ends cemented or closed—this covering to extend through the wall. In no case allow a service to be levelled with stone or brick or extend through a wall without a box or tile around it. Now, as to the house riser and meter in exposed places, a dehydrator, a description of which appeared in the American Gas Light Journal, March 7, 1904, could be used to good advantage. This is the wrinkle of Mr. F. C. Shepard, of Minneapolis, and I understand his company has some 300 in use with perfect success. The device costs but a trifle, and the maintenance is very low, requiring only a little excelsior and broken up lime. Once a year these are changed and others substituted, the old ones being refilled. Now, a word for the lamp post. Some years ago, having much trouble with keeping lamp post risers free from frost, I conceived the idea of setting every post to form a dead space. This was accomplished by fitting boards tightly over the two slots in the base of the post, keeping the post free from dirt and the ell at the bottom entirely free of any covering, the top of the post being plugged with a wooden block with an inch hole for the rise pipe to pass through. I found this remedy almost perfect, and the posts required very little attention. In short, I believe that gas companies in general are not paying enough attention to the details of the service laying.

Mr. Butterworth—In reply to Mr. McAdam, we did use alcohol in the bridge lines, at Grand Rapids, of course, in large quantity, but I do not believe that this was the cause of the reduction in the number of freeze-offs in the territory supplied through them, because it was evident, from the frost found in these pipes, that here was where the moisture had already been deposited out of the gas. Mr. Miller's objection to the drying out of the diaphragms I think was answered by Mr. Mitchell. We don't need, necessarily, to dry the gas completely; we could dry it as much as is necessary to prevent these interruptions, and leave some moisture in the gas, so that the meter diaphragms will not necessarily be dried out. Mr. Elbert pleads that conditions in St. Paul are not bad, as they only had 2,700 different consumers affected by interruptions in their gas supply during the winter. I think that is very bad. He admits himself that some of these 2,700 had duplicate interruptions. Probably some of them had triplicate interruptions. If he had 2,700 different consumers out of gas in one winter, that probably means 4,000 or 5,000 individual interruptions in a town not having more than probably 15,000 or 16,000 consumers. I think that is very bad. No matter how much better we may be doing than possibly some other public service corporations, it is up to us to do still better if we can, undoubtedly. I think his device for preventing individual freeze-offs in those particular services which he knows to be bad and liable to make trouble, is all right; but it is only a makeshift after all. It is only a partial remedy. We don't know where these troubles are going to occur. They appear where we least expect them, and where they don't appear in one severe winter, they may appear in the following, although it is not so severe. That has been the experience of all of us.

CONCERNING RETAINING WALLS AND EARTH PRESSURES.

By H. P. Boardman.*

To forestall a possible misconstruction of remarks to follow, it may be well to state here that the writer is a firm believer in theory as applied in engineering practice, i. e., correct theory. But in the application of mathematics and mechanics to engineering problems, common sense should play a large part. When we assume as a constant, something which may vary so as to change the results 50% to 100% and then develop a mathematical formula or an ingenious graphical solution of the problem, are we justified in expecting results to be within 5% or 10% of being correct? Such seems to be about the status of the theoretical treatment of lateral pressure of earth.

About 25 years ago, in a paper before the Institution of Civil Engineers, Sir Benjamin Baker said, concerning the lateral pressure of earthwork:—"The mass of existent literature on the subject is both misleading and disappointing, for with little exception the bulk of it consists merely of arithmetical changes rung upon a century-old theory, which even at the time of its inception was put forward but as a provisional approximation of the truth pending the acquirement of the necessary data." He quotes the following from Rankine:—"There is a mathematical theory of the combined action of friction and adhesion in earth; but for want of precise experimental data its practical utility is doubtful." And yet Rankine's theory is considered one of the best, and doubtless many who use it have more faith in its accuracy than its author evidently had.

This paper of Sir Benjamin Baker's gives the best treatment the writer has seen on the subject from a practical point of view. He cites many experiments, some direct or designed, and others indirect or occurring on practical construction work. For the latter he draws extensively from his experience in the construction of 9 miles of retaining walls and 34 miles of deep timbered trenches and tunnels. The experiments and observations above referred to, nearly all show lateral pressures only one-third to half those indicated by the most accredited formulas.

He concludes that "experiment has shown the actual lateral thrust of good filling to be equivalent to that of a fluid weighing 10 lbs. per cu. ft., and allowing for variations in the ground, vibration and contingencies, a factor of safety of 2, the wall should be able to sustain at least 20 lbs. fluid pressure, which will be the case if one-fourth of the height in thickness." In practice he usually makes the thickness one-third the height from the top of the footings. Assuming his conclusions as to actual earth pressure to be substantially correct, his factor of safety appears to be too low, considering the many uncertainties as to conditions of filling and foundation.

Nearly all the literature of more recent date than Sir Benjamin Baker's discussion, is open to his criticism of being based on the same old theories and assumptions. It seems also that those who have worked out elaborate formulas or graphical solutions generally deem it entirely unnecessary to verify their results or prove their assumptions correct by experiment. This appears extremely surprising in view of the general tendency to test by experiment every possible theory relating to the strength and other mechanical properties of materials entering into engineering structures.

Let us for a moment turn to the somewhat analogous subject of the pressure of grain in the bins of grain elevators. In the Engineering News of March 10, July 14 and Dec. 15, 1904, are the records of three different sets of tests in this line. While the results of these tests vary somewhat with the kind of grain and with the condition (as to moisture, etc.) of a given kind of grain, they are more uniform than results we could expect to get from tests of the lateral pressure of earths of widely different character. Some of the results of these tests show the following: 1, that the pressure does not vary directly with the head as in the case of a fluid, but that the pressure curve starts out practically tangent to the theoretical fluid pressure line and curves away from this straight line, the pressure becoming less and less in proportion to the depth; 2, that the curves of vertical pressure on the bottom of the bin and lateral pressure on the sides of the bin are the same in character and that in all cases the pressure reaches a maximum (usually when the head is between 30 and 50 ft.) beyond which point the pressure is practically constant no matter what depth of grain is added on top; 3, that the vertical pressure at the bottom is greatest near the center and gradually lessens toward the sides, becoming practically the same as the lateral pressure at the side of the bin; 4, that there is little difference in pressure under a given head whether the bin is filling or emptying or head remaining constant, and that suddenly closing the discharging chute produces very little effect on the pressure.

Some conclusions from these results are that the only pressure on the bottom of the bin and also on the side near the bottom is that due to a dome-shaped mass of grain immediately above the bottom, and that all grain above this mass is carried entirely by friction between the grain and the sides of the bin; that for a given grain, the pressures depend on the height of this dome-shaped mass which in turn depends on the horizontal dimensions of the bin and, up to certain limits, on the friction between the grain and the bin walls. One of these series of grain bin tests, that of Jamison (Engineering News, March 10, '04), included similar tests of dry sand on a small scale and the results were exactly similar to those with grain.

It will be seen from this that in the case of retaining walls we have very considerable downward force acting at the back of the wall which will add materially to the stability against overturning. This is in accord with the retaining wall theories which take account of the friction between the filling and the back of the wall, giving an inclined direction to the resultant pressure. But the shape of the pressure curves of these grain bin tests is greatly at variance with retaining wall theories in that the latter all give pressures varying directly with the depth, i. e., equivalent to fluid pressures.

The only recent experiments on lateral earth pressures, of which the writer has found record, were made at the University of Nebraska and in Engineering News of Oct. 19, 1899, there was published an abstract of this thesis. The pressures were measured by two movable boards, 12 × 12 ins., in the vertical face of the timber retaining wall. The centers of these boards were respectively 1 ft. and 3 ft. above the bottom of the wall. The pocket behind the wall where the filling was placed had a bottom sloping down towards the wall, was only 6 ft. 6 ins. front to rear by 7 ft. long at top of this slope, increasing to 9 ft. front to rear by 7 ft. long at top of pocket; the total height of wall was 15 ft. 6 ins. It will be seen that conditions were quite similar to those frequently obtaining behind retaining walls, except regarding the restricted length of wall. These experiments were not carried far enough to be conclusive, the maximum heads being 12.5 and 14.5 ft. above the upper and lower boards, respectively. The earth used in the tests weighed about 80 lbs. per cu. ft. dry, and the average angle of repose was about 37°, or a slope of 1.35 to 1. For the same heads above boards the pressures on the upper board were 70% to 80% greater than those on the lower board. This evidently does not check the equivalent fluid pressure theory. The curve for dry

*Bridge and Building Department; Chicago, Milwaukee & St. Paul Ry., Chicago.

earth pressures on lower board with surface level gives the following:

Head (ft.)	3	6	9	12
Pressure (lbs.)	80	130	155	175

The curve for same with inclined surface, i. e., surcharge at 30° slope, is practically parallel to the above with a constant difference of about 20 lbs.

The pressure curves for the upper board under the same conditions are similar in shape and show larger pressures, as above stated. In this case the surcharge pressures were 30 to 50 lbs. more than those for level top.

It will be seen that these dry earth pressure curves are similar in shape to the corresponding lower parts of the grain bin pressure curves, and if tests had been extended to greater heads it might have been found that the pressure reached a maximum and then remained practically uniform.

The experiments with damp earth were only carried to heads of 9 and 11 ft. on the lower board and with mud only to 5 ft. head. The pressures with damp earth were practically the same at the maximum heads as for same heads with dry earth, but below these heads were much more irregular. The mud pressures were higher, reaching about 400 lbs. at 5 ft. head, but were greater in proportion at lower heads showing the same tendency to curve as with the dry earth pressures.

Assuming that the curve in Fig. 1 represents a characteristic curve of earth pressure and the straight line fluid pressure, the total pressures would be represented by the areas between these lines and the "Y" axis, or vertical back of the wall. The resultant pressures would be F, applied at ⅓ the height from the bottom for fluid pressure or, E, applied about 37% of height from bottom for earth pressure. Taking moments about the bottom of the wall it will be seen that while E has slightly the greater moment arm, its moment will be much less than that of F, as the curve area is much less than the triangle area. In cases where the unit pressure becomes a constant under considerable heads as in the grain bin tests the point of application of "E" would rise above 37% of the height.

In Engineering News of Feb. 7, 1901, is an abstract of a paper by Chas. Baillairge, former City Engineer of Quebec, in which he cites a number of instances of retaining wall failures in that city, which he says is preeminently a city of retaining walls. These failures he ascribes largely to the fact that the filling frequently became saturated with water and that frost action in the winter aided in crowding the walls forward, while they were designed on the supposition that they only had to support the lateral thrust of dry filling. Their thickness was only 1-7 to ⅓ of their height with frequently no weep holes or other provision for drainage and yet they did service for from 10 to 50 years and doubtless much wall still standing has no greater thickness than ¼ its height. In some of the above cases the failures were gradual, the walls being crowded forward a little at a time till final failure or until taken down to prevent failure. In such cases the moment of stability was greatly reduced and was doubtless much less than would be required to withstand the pressure that theory would indicate it was supporting. In commenting editorially on the above paper, the following statement was made in Engineering News:

> The futility of fine-spun computations becomes apparent when we substitute the actual material behind the wall for the theoretical, and consider that its character continually changes with changes in moisture and temperature that every changing season brings. Good drainage can add more years to the life of a retaining wall and save more cubic yards of masonry in its construction than any other thing in connection with it. In fact it may not be far wrong to say that there is more need of good engineering in placing the filling behind the wall than in building the wall itself.

The only total failure of a retaining wall that the writer has ever observed was caused by saturation of the back filling and no provision for drainage. This wall had a thickness of only about ¼ the height.

All who have spent much time around engineering structures during construction have observed facts that conflict with the assumptions on which retaining wall theories are based. The grain bin experiments seem to disprove them as far as dry granular materials like grain and sand are concerned. Much (and probably a majority) of the backfilling material used behind retaining walls contains enough clay or similar substance to give it considerable cohesion, at any rate cohesion generally exists to a marked degree, some of the theories to the contrary notwithstanding.

The standard theories may be interpreted as equivalent to assuming that at the time backfilling is commenced, we already have a bank standing with toe of slope just meeting the heel of the retaining wall, and that the surface of this slope is a plane and in some unaccountable manner has been rendered absolutely immovable as though it were a surface of solid rock, and bearing no relation to the filling to be placed on it, except that its inclination equals the angle of repose of that filling and that the coefficient of friction between this surface and the filling, equals the tangent of that same angle of repose. As a matter of fact we never have this condition fulfilled. Even when we have the bank with this slope meeting the foot of wall as above described, if this bank is of similar material to the filling to be

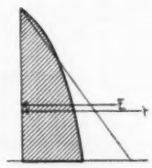


Fig. 1.

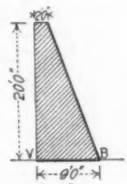


Fig. 2.

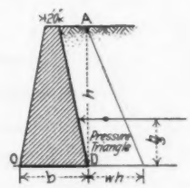


Fig. 3.

Fig. 5.

placed on it, it will be compressed to some extent and the filling and the original bank settling together will develop cohesion. We can not conceive of any imaginary surface within a body of backfilling that is similar to the exposed sloping surface of a bank, except it be in some perfectly dry, granular material. Every surface below the top of a mass of backfilling has been subjected to pressure which in ordinary filling materials results in compression, developing cohesion, while the exposed surface of a bank inclined at the angle of repose has no pressure from above except atmospheric.

In one case a switch track was built along the side of a 40-ft. fill by cutting a ledge in the fill and casting over, making the slope on the cut side of the switch-track much steeper than 1 to 1. This track, probably at least 1,200 ft. long and extending from top to bottom of the fill, was operated as a construction track for nearly if not quite a year, with regular heavy traffic continuing on the bank above and yet no serious caving was caused by it. This was on a fill that had taken a natural slope flatter than 1½ to 1. Many other instances observed by the writer of cutting into railway banks could be cited, showing that packing had developed cohesion to a remarkable degree.

Of those who assume that no cohesion can exist in the filling back of a retaining wall, it may be asked what prevents molder's sand from caving in when the pattern (merely a temporary retaining wall) is removed. The angle of repose of molder's sand cast loosely into a heap probably ranges between 1½ to 1 and 1 to 1, varying with the amount of moisture it contains.

While this packing effect is least, soon after the filling is placed behind a retaining wall, it is present to some extent from the start, and by a comparatively small expenditure it may be greatly increased.

Enough has been said here to show that Rankine's doubts concerning the practical utility of the theories of lateral earth pressure were well founded, inasmuch as their assumptions and deductions are plainly out of accord with experiment and observation.

Prof. Ira O. Baker in his book on "Masonry Construction" gives the principal retaining wall theories, the assumptions on which they are based and points out their defects. He discredits them all and says—"something must be assumed in any event, and it is far more simple and direct to assume the thickness of the wall at once than to derive the latter from equations based on a number of uncertain assumptions." This is very well for the ordinary solid masonry or concrete retaining wall when the person deciding on the thickness uses good judgment based on his own or others reliable experience under similar conditions.

But with the advent of reinforced concrete and its application to retaining walls, it is more a question of design, and this work of design frequently falls to the lot of some draftsman who, however much he knows of the properties of structural materials (including reinforced concrete), has had no personal experience with retaining walls or the lateral pressure of earth. Being familiar with the use of formulas and graphics in his other structural work he naturally inclines to the use of one of the retaining wall formulae bearing the name of some noted engineer or mathematician of unquestioned ability, and just as naturally he expects results commensurate, in accuracy, with the labor required to obtain them.

But owing to the lack of sufficiently varied and reliable information on the actual lateral pressure of earth, a more sensible course is to obtain from some experienced engineer a decision as to what section he would adopt for a solid concrete or masonry wall to fit the case in hand, and then design a reinforced wall of equal stability, bearing in mind that the lighter reinforced wall, while it may decrease the load on the soil, will on account of its lightness have less stability against moving forward bodily than the heavier solid wall.

It will be in order to give a few figures merely as a basis for comparison between the solid type of wall and others. In doing this the writer makes assumptions which will seem inconsistent with what has been said before, but it must be borne in mind that he does not claim great accuracy where these assumptions are concerned.

First, as to an unqualified recommendation for a certain ratio between thickness and height. Let Fig. 2 represent the section of a solid concrete retaining wall resting on a firm base or footing. Considering merely the gravity moment of stability and assuming the weight of concrete at 150 lbs. per cu. ft. the moments of 1 ft. length of wall are 51,500 ft. lbs. about V and 97,000 ft. lbs. about B. These figures would represent the relative stability or difference between the batter on the rear and on the front if only the horizontal component of the earth pressure were considered. From this it is evident that to say a wall must be 40% or 45% of its height in thickness does not tell what its stability will be.

To show approximately the relation between a typical solid retaining wall (Fig. 3) and the equivalent fluid pressure required to cause an overturning moment just equal to the gravity moment of the section, let us make the following assumptions:

1. A constant top width of 2 ft.
2. Equal batters on front and rear.
3. That only the horizontal component of the earth pressure is considered, and that an imaginary vertical plane A-D (Fig. 3) takes this pressure which is transmitted to the wall horizontally through the intervening earth.

4. That the wall rests on an unyielding base or footing.

5. That moments are taken about the toe of the wall "o."

Let w = weight per cu. ft. of equivalent fluid pressures.

" 150 lbs. = weight per cu. ft. of concrete in wall.

" M_o = overturning moment.

" M_s = stability moment.

Then $$M_o = \frac{w\,h^2}{2} \times \frac{h}{3} = \frac{w\,h^3}{6}$$

and $$M_s = 150\left(\frac{2+b}{2}\right) h \times \frac{b}{2} = 75\,h\left(b + \frac{b^2}{2}\right).$$

Placing $M_o = M_s$ and solving for b we have

$$b = \frac{\sqrt{w\,h^2 + 225}}{15} - 1.$$

Or, assuming a constant value for b/h and solving for "w" we have $$w = \frac{225\,b^2 + 450\,b}{h^2}$$

h	w = 50 lbs. b	w = 50 lbs. b/h	b/h = .4 w
5	1.56	.312	72
10	3.82	.382	54
15	6.14	.409	48
20	8.46	.423	45
25	10.81	.432	43.2
30	13.17	.439	42
35	15.50	.443	41.1
40	17.85	.446	40.5

In the first part of the table herewith, "w" is assumed a constant at 50 lbs. per cu. ft., in which case it is seen that b/h increases with the height of the wall.

In the second part of the table the values of w are obtained from the last equation by substituting for b its assumed value, .4 h, giving $w = 36 + \frac{180}{h}$.

In designing a reinforced wall the use of such a formula as $M_o = \frac{w\,h^3}{6}$ is a very convenient method of determining the overturning moment which is to be opposed by the moment of stability. Judging from the grain bin and retaining wall tests herein referred to, I think such a formula with values of "w" varying similarly to the last column of the above table, more nearly fits the case than with a constant value of "w." It is interesting to note that this corresponds to a quite common practice of specifying a constant ratio, b/h. Fig. 4 shows curves for the last column of the table and for $\frac{w\,h^3}{6}$ corresponding to $w = 36 + \frac{180}{h}$ lbs. and $w = 36 + \frac{180}{h}$ (or $b = .4\,h$).

It is assumed that a footing is used under a wall of section like Fig. 3, suitable to spread the pressure safely to the soil below. It is also assumed that there is no adhesion between the footing and the main wall to transmit tension across the joint. The effect of the friction between the back of the wall and the earth has been neglected. This would tend to introduce a force adding materially to the factor of safety of the main wall and removing the point of application of the resultant pressure on the soil farther back from the front of the footing. In many cases after the filling has become thoroughly compacted, where it is impervious or where drainage has been provided for, this frictional force practically vanishes, but in this event the pressure against the wall is also very much lessened.

I do not like the tendency of some to use the term "factor of ignorance" instead of "factor of safety," for even though we know to a practical certainty all the conditions involved, we are obliged to use this factor of safety, varying in size according to the kind of structure or part of machine in question, and the use to which it is to be put. But if ever the term "factor of ignorance" is justifiable I think it is in connection with the stability of retaining walls. As pointed out by Engineering News in the editorial above quoted from, the character of the filling, and with it the pressure and the factor of safety, changes with seasons and with temperature and humidity. Very commonly the factor of safety is least when the filling is just completed, which is often when the concrete is comparatively fresh.

The typical reinforced wall section shown in Fig. 5, if designed to have stability equal to that of a solid wall of section like Fig. 3, should have the front wall reinforced to carry the pressure to the counter forts and they in turn should be reinforced to anchor this front wall to the back step of the footing. The back step should be wide enough to support sufficient filling to bring the stability of the combined earth and concrete up to that of the solid wall. The front step should extend far enough to reduce the maximum pressure on the soil to reasonable limits. The footing if thin will also need reinforcing. It is surely safe to assume that all the earth vertically above the back step acts as part of the wall, and it is likely that in case of overturning about the toe of the footing, the surface of rupture in the filling would at the first stage of the failure incline back of the vertical plane at the heel of the back step.

In view of the uncertain and variable factor of safety of the solid wall, and the fact that in the above treatment of the section, Fig. 3, certain things were neglected which would add to its stability, it would seem wise to design the reinforced concrete of Fig. 5, to require only about one half its ultimate strength at the point of overturning. If designed for ultimate strength at the ultimate stability of the wall, the factor of safety might at unfavorable times be reduced so low as to open up tension cracks in the concrete large enough to admit moisture and so corrode the reinforcing steel. If no other means are at hand to prevent sliding forward, the footing should be carried well below the surface to insure stability in this respect.

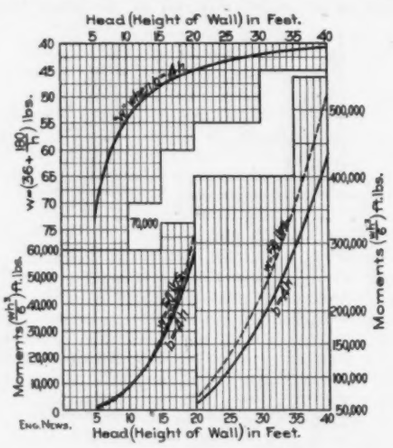


Fig. 4.

It is well to bear in mind that in nearly all cases of failure it is the foundation soil under or in front of the toe of the wall that first yields, permitting the wall to tip or move forward. Foundation piles if all driven vertically, will afford less lateral stability in very soft mud than the wall would have if piles were omitted and the footing spread over a large area.

The effect of surcharge is as hard to predict accurately as the lateral pressure with a level top, and I think in many cases it is overestimated.

Again, referring to Sir Benjamin Baker, he states that he once applied to a box full of sand a pressure equivalent to a column of that material 1,400 ft. high. He says that a few pounds lateral pressure would have burst the box, and therefore the jamming of the sand between the lid and the bottom must have prevented much increase in the lateral pressure.

Similar effects are noticed in the use of sand jacks for lowering bridges, arch centers, etc. In Engineering News of Dec. 31, 1903, Mr. Lincoln Bush described the sand jacks used in lowering a heavy drawbridge. Some time before this was done, he tried two experimental sand jacks under a load of 2,250 lbs. per sq. foot. These experimental jacks were 4 ft. by 6 ft. by 6 ft. high inside measure. The sand was perfectly dry. Holes were bored through the sides horizontally and at 30° and 45°, and also vertically through the bottom. No sand would flow through the horizontal holes. The 30° holes flowed about half full and the 45° holes nearly full, while the bottom vertical holes discharged the sand more freely. All the holes were tapered from ins. dameter at inside to 2 ins. at outside of wall, and the same was true of the holes in the large jacks used for lowering the drawbridge. In both cases the bottom edges of the plungers were rounded off to about ½-in. radius and a clear space of ½ in. all around was left between the plungers and the sides of the boxes. In the large jacks the weight on top of the sand was 2,815 lbs. per sq. foot, but no flow whatever of the sand occurred through the ½-in. spaces surrounding the plungers occurred. Mr. Bush says:

> The experimental tests as well as the work done in connection with lowering the drawbridge, show most conclusively that there was no intense lateral pressure from the sand against the vertical sides of the boxes and that the sand acted practically as a column under the load of 2,815 lbs. per sq. ft. The sand running through the holes in the bottom of the box, as well as the holes set at an angle of 45° in the sides of the boxes, did not flow with force or as if under pressure. A very slight pressure of the hand over any of the holes was sufficient to stop the flow of the sand.

In both the test boxes and the large jacks the sand was compressed about 0.74% of its total volume.

In Engineering News of Jan. 21, 1904, it is stated that a sand jack was used in lowering into place the shaft of the Battle Monument at West Point. Here also it was found necessary to use a conical bottom opening in order to get a satisfactory flow of sand, which was thoroughly dried. In this jack the pressure on the sand was 22½ tons per sq. ft., and yet the total compression of the sand was 0.78%, almost the same as in Mr. Bush's large jacks where the pressure was less than 1½ tons per square foot.

From these illustrations it would appear that with dry sand filling, heavy surcharge or superimposed load has but little effect on the lateral pressure.

With clay filling containing moisture enough to render it plastic the effect on the lateral pressure would be considerable.

In the University of Nebraska tests the increase of pressure from surcharge was noticeable but not very great in proportion to total pressure. The material was probably a loamy clay. As the filling material becomes more plastic through added moisture, the effect of surcharge cannot continue to increase in proportion to the lateral pressure due to level filling; for the maximum lateral pressure for level filling would be when it became a fluid of approximately the same weight per cubic foot as the solid filling. In that condition the angle of repose would be zero so there could be no surcharge, and the filling could support no superimposed load except by floating it.

When it is expected to place a railway track or heavy structure on top of a fill near a retaining wall, the fill is generally made of good material that will carry the weight without much yielding. If, as additional precautions, good provision is made for drainage, and the filling is well tamped into place, the factor of safety of the wall will be increased a great deal more economically and scientifically than it would be by enlarging the wall and neglecting the filling and drainage.

This subject, the lateral pressure of earth, appears to be a most appropriate one for future experiments. Some may say that it is useless, since it is impossible to cover all the cases that will arise, and that conditions vary so widely in any given case at different times that experimental results will not be conclusive. Granting that there is much truth in this, yet the more reliable

information we can get on the subject the less guessing we will have to do. Again, it may be that if we know approximately the pressures to expect under different conditions with a given kind of filling, we will find it more economical to guard against the worst contingencies and build accordingly, than to build to withstand the worst that may happen.

Such tests should be made on a large scale extending up to heights of at least 25 or 30 ft., and instead of trying to measure the pressure on a small board near the bottom of the wall, more useful results will be obtained if the full overturning moment due to the earth pressure can be measured by a movable section of the wall. The wall could be of timber and this movable section, which should probably be at least as long as the total height or maximum head to be tested, could be hinged at the bottom to permit of inclining at different angles in different tests.

The tests should cover a number of different kinds of material and under different conditions as to moisture contained. This would necessitate either making the tests in different places or transporting part of the material to the site chosen for the tests. Also the effect of tamping the filling should be compared with dumping it into place loosely.

In view of the great amount of money to be spent in the future on structures built to withstand earth pressures, it seems that a few thousand dollars spent on such a series of tests would be a good investment. Why would not this be a worthy cause for a donation from some philanthropist or an appropriation from some technical society or school of engineering?

BLUE PRINT APPARATUS WITH AN ORDINARY WINDOW AS GLASS AND PART OF FRAME.*

By H. O. Garman.†

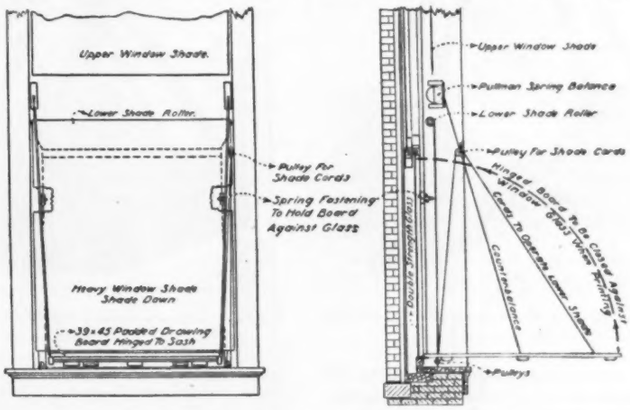
The blue print frame to be described in this article is particularly applicable for use in the office of a consulting engineer, contractor, small railway division headquarters, etc. It has served a useful purpose in the blue printing work done for the school of Civil Engineering in Purdue University. After considering all the points of economy both in the cost of apparatus and production of prints where the sun must generally be used as the source of light a contrivance for exposing the sentitized paper to the sun should provide for the following features: (1) Minimum time of exposure; (2) protection of the tracings while exposing; (3) ease of placing the prints in frame and exposing same: (4) protection of the operator from the weather; (5) no dark room for cutting paper; (6) least possible encroachment on inside space in office.

The requirements are: (1) A south window; (2) a drawing board the size of the window glass; (3) a supply of heavy table padding and cotton batting; (4) two Pullman spring window counterbalances; (5) an ordinary roller window shade; (6) three hinges; (7) two spring catches; and (8) some strong cord. It is not necessary to purchase a glass of any kind, since the regular window glass is used. (See illustration.)

Cut one piece of the table padding large enough to cover the board, with surplus to allow tacking to the side. Cut the remaining piece of padding into four other rectangles, each being made smaller than the preceding. Place the pad rectangles concentrically on the board, then cover uniformly with cotton batting and over this place the largest piece of pad mentioned above, the same being tacked to the sides of the board when well stretched. This gives a pyramidal or convex form of cushion which insures a uniform pressure against all parts of the window glass, the elasticity of the glass allowing it to bulge into this form. Experience shows that the window glass should be held in place with screws and wooden strips, putty not being strong enough to permanently stand the pressure. Next, place the padded board in the window and attach the hinges to the lower side of the board and to the bottom sash bar; attach the spring catches on the top sash or on the side sashes near the top. This holds the board firmly in place. The balancing apparatus, consisting of the two Pullman spring counterbalances, is attached one on each window casing about opposite or a few inches above the top sash, the suspenders being attached to the board on each side at such a point between the top end and the hinge as to produce equilibrium. The roller window shade is fastened to the casings about 4 ins. above the top end of the board an inch from the sash, and both of its catches removed, making it possible to run up or down without interference. The shade is operated automatically as the board is raised and lowered, thus shutting out the light when the board is horizontal and the sensitized paper is being inserted, and running up out of the way as the board is raised to a vertical position against the window for printing. The cord operating the curtain passes down from its two lower corners through two pulleys in the window sill, where one cord passes along the bottom sash to the other pulley. Here both cords ascend together to a third pulley on the casing where they both again descend a short distance and are attached to the board. The position of the third pulley on the casing and also the point of attachment to the board must be adjusted so that the cord distance from this pulley to the point of attachment when the board is in a horizontal position is equal to the distance the shade must travel down to shut out the light. When printing, the regular shade is drawn to where the other roller is attached, thus shutting out the light from the upper window.

When not in use the hinge pins may be drawn, the suspenders and shade cords unhooked and the board removed, leaving the window entirely unobstructed and no floor space occupied. If but one print of a tracing is wanted, fasten the tracing on top of the sensitized paper by putting at each corner a common pin through both and into the padded board. When the board is pressed against the window glass it will hold the tracing smoothly and firmly against the paper.

When a considerable number of prints are to be made from one tracing this apparatus is exceptionally rapid. Take four pieces of chamois, ½ to 1½ ins., at one end of which are attached two or three small rubber bands looped together. Pin one of these pieces to each of the corners of the tracing and draw the rubber bands over the edges of the board and hook them over the heads of brass tacks placed along the edge of the board on the back side. Then to make any number of prints cut the paper to size and slip it under the tracing, raise the board against the glass, expose a sufficient interval, then drop the board, draw the paper out, and wash it. With this arrangement, using fast paper and good sunlight one large print every 70 seconds has been made. If working during a heavy rain storm the tracings are protected from water, everything about the apparatus being inside the room.


Upper Window Shade
Lower Shade Roller
Pulley For Shade Cords
Spring Fastening To Hold Board Against Glass
Heavy Window Shade Shade Down
39 x 45 Padded Drawing Board Hinged To Sash
Upper Window Shade
Pullman Spring Balance
Lower Shade Roller
Pulley For Shade Cords
Hinged Board To Be Close Against Window Glass When Printing
Cords To Operate Lower Shade
Counterbalance
Pulleys

A NOVEL BLUE PRINT APPARATUS.

The following statement of the costs of apparatus to take a 3 × 4-ft. tracing includes that just described and the ordinary blue print frame, together with the high-priced appliances:

(1) The best electric macnine (listed)	$500.00
(2) Vacuum sun frame (listed)	75.00
(3) Felt cushion sun frame (listed)	80.00
(4) Apparatus above described	6.87

The last named is itemized as follows:

1 Drawing board	$1.75
2 Pullman spring window counterbalances at 82½ cts.	1.65
2 yds. of table padding at 70 cts.	1.40
1 window shade with mountings	1.20
3 pair hinges at 10 cts.	0.30
3 pulleys at 5 cts.	0.15
2 spring catches at 10 cts.	0.20
1 roll cotton batting	0.12
12 feet of strong cord	0.10
Total	$6.87

To summarize, the device here described has the following advantages: (1) It is adapted to offices requiring a moderate amount of blue printing, and where the more costly appliances can not be afforded for lack of either means or space; (2) notwithstanding the large size of the board the counterbalancing device enables one to insert and remove the materials easily, with no annoyance in raising or lowering a large window; (3) minimum time of exposure and the protection of the tracings and operator from the weather; (4) no dark room or boxes required to cut the small pieces of paper, but several tracings being printed on the full width of the roll and then cut apart in the full light after the prints have been dried.

*Condensed from an article entitled "A Novel Blue Printing Apparatus," in "The Engineering Review," Purdue University Annual for 1905.

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DAILY WARNINGS AS TO THE SAFETY OF THE WATER SUPPLY OF CHICAGO.

For some time past there have been published in the daily papers of Chicago statements regarding the safety or danger, as the case might be, of the water as taken from the various lake intakes and distributed to different sections of Chicago. This was particularly necessary in the old days of serious pollution from the Chicago River before the Drainage Canal was open. Variations in lake levels and wind directions made the water much more dangerous at some times than at others, and warnings to boil the water were often given by the health department. Of late, with the diversion of a large part of the city's sewage from the lake, the water has been pronounced "safe" a large part of the time. There is still reason, however, for keeping the public appraised of fluctuations in the character of the water. At our request Mr. Chas. J. Whalen, M. D., Commissioner of Health of Chicago, has asked Mr. Frederick O. Tonney, Assistant City Chemist, to prepare a statement as to the basis used in pronouncing the water safe or unsafe. Although the details will be familiar to many of our readers, they will be new to others, and the general principle involved will very likely be interesting to even those who are well versed in sanitary water analyses. Mr. Tonney writes:

It is of course understood that the essential point of sanitary water analysis is the determination of sewage contamination, since it is only through the agency of sewage that bacillus typhosus and other dangerous intestinal forms of bacteria can find their way into the water supply. Under ordinary conditions, considering the well known principle of the self purification of running water, it is not to be expected that the waste matter from the few remaining sewers along the lake front should be carried as far as the cribs, i. e., from two to four miles; but nevertheless such contamination does occur at intervals, and owes its cause no doubt to changing currents, off shore winds, and the flushing out of the sewers by heavy rainfalls.

The important point in analysis, then, is the determination of dead animal matter, and this is accomplished by means of the ammonia test, free ammonia representing decomposed proteid or albuminous matter, and albuminoid ammonia indicating undecomposed living or dead matter of the same character. From time to time analyses are made of the undefiled water from mid-lake. A certain "normal" amount of free and albuminoid ammonia is found to be present—usually (in parts per 100,000) about 0.001 free and 0.007 albuminoid—which owes its presence to certain harmless micro-organisms which are natural habitants of all fresh water. In case, however, that sewage has reached the cribs, we find that the ammonias are present in much larger quantities. As a rule, water showing as much as 0.002 (parts per 100,000) of free, and 0.009 (parts per 100,000) of albuminoid ammonia is to be regarded as doubtful, and anything above this is dangerous.

In addition to the ammonia test, the "oxygen consumed" test is also used. It consists simply in a determination of the amount of oxidizable material in the water. This test, however, is not a sure index of animal matter, but merely indicates organic matter, which

may be either animal or vegetable in character. The test is valuable only when used in conjunction with the ammonia test. It serves to distinguish organic, and hence questionable sediment, from mere sand or soil, and is valuable as a corroborative test in case the results of the ammonia test indicate animal matter.

The result of the chemical analysis, taken together with such data as the direction of the wind, weather conditions, positions of the crib, etc., goes to determine the "safety" of the water.

Bacteriological analyses are also made in the laboratory, but on account of the length of time required for such analyses it is found to be impractical as a basis for predicting the safety of the water to be used during a given day.

A NEW CLAM-SHELL DREDGE-BUCKET.

In 1846 the first United States patent on a clam-shell dredge bucket was issued. Since then several hundred patents have been granted, and each year adds to the number. In many cases the

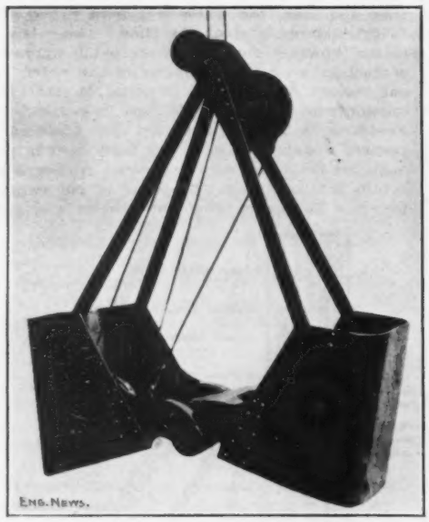

Fig. 1. The Williams Clam-Shell Dredge-Bucket Open.

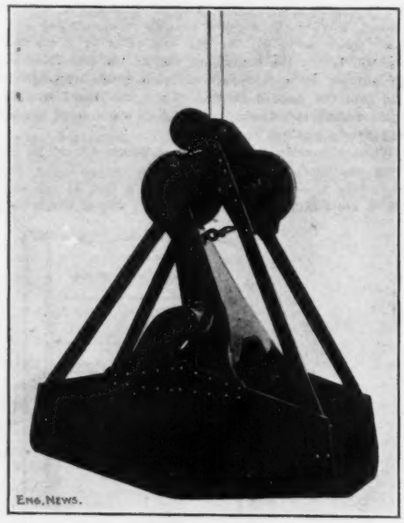

Fig. 2. The Williams Clam-Shell Dredge-Bucket Closed.

designs are complicated and of questionable value, but the bucket illustrated in Figs. 1 and 2 is noteworthy because of its simplicity.

It will be seen that the two scoop members are hinged together in the ordinary way, but that the hinge end of one of the scoops extends beyond the hinge, forming an arm at the outer end of which is a sheave. At a point near the outer end of this arm is dead-ended a cable which passes around one of the sheaves located in the "head" of the frame supporting the scoops. The cable passes back around the sheave at the end of the arm, up to and under the second sheave in the "head." This cable, thus multiplied, forms the closing power of the bucket.

To the "head" is attached a second cable which is used to lower the bucket and to hold it in position while opening.

Among the buckets in use is one of 3 yds. capacity on the lighter "Rescue," owned by the Great Lakes Towing Co., of Cleveland, Ohio. This bucket has been subjected to severe use under adverse circumstances and has given satisfaction.

The bucket is the invention of Mr. Williams, of G. H. Williams Co., 1512 Rockefeller Bldg., Cleveland, Ohio, by whom the bucket is manufactured.

THE RAILWAYS OF INDIA in April, 1905, had an aggregate length of 27,904 miles, with 3,035 miles under construction or authorized. The 27,565 miles in operation at the end of 1904 were of four different gages, as follows: 5 ft. 6 ins. (Indian standard gage), 14,733 miles; meter gage, 11,562 miles; 30-in. gage, 942 miles; 24-in. gage, 328 miles. Of the total equipment there are 2,630 engines (47.31% of total), 10,401 passenger cars (52.29%), and 2,883 freight cars (2.67%) fitted with automatic brakes, while 9,385 passenger cars are fitted with gas and 485 with electric light. During the year a change was made in the administration, which is now in the hands of a Railway Board composed of three members, instead of being in the hands of the railway branch of the Public Works Department of the Indian government. The number of passengers and employees killed and injured were 389 and 871, respectively, while the total casualties amounted to 1,156 persons killed and 1,089 injured. The employees numbered 421,866, of whom only 6,236 were Europeans and 8,765 Eurasians, the remainder being natives. Five standard designs for locomotives have been adopted, as submitted and recommended by a special committee of engineers.

MARINE GAS ENGINES for auxiliary power on sailing vessels are being introduced with considerable success on the Pacific coast. The engine drives a screw propeller to assist in working the ship in and out of harbor without the expense of a tow boat, and it also drives a capstan and hoist for raising anchor and handling the sails and cargo. The Hercules Gas Engine Works, of San Francisco, Cal., has in the past ten years equipped about 50 ships in this way; the largest are 106 ft. long, mainly of 150 tons, with 70-HP. engines; but the "Eclipse" of 163 tons has an engine of 175 HP. The gear connection between the engine and propeller shaft enables the propeller to be driven in either direction or disconnected without altering the running of the engine. In some cases a two-bladed propeller is used, which is set vertical when the ship is sailing. Usually, however, a three-bladed propeller is used, and is left to revolve freely. A speed of five to six miles per hour can be maintained. The space occupied is very much less than would be required for a steam engine with boilers and coal bunkers, and is ready for service at any time, while no special engine room crew is required. As a rule only a single engineman is carried, as the engine is not run continuously.

THE DREDGE "SIR WILFRID," SUNK in Lake Ontario, Oct. 6, 1902, during a storm, has been located in 78 ft. of water, between New Castle and Port Hope, Ont., about 2½ miles from shore. Mr. W. W. Sparke, of Pickering, Ont., found her and will receive $500 as reward from The Polson Iron Works, of Toronto, Ont., the [illegible] that built the dredge. The dredge had just been finished and was being towed for delivery to W. J. Poupore, contractor, of Montreal, for whom she was built, when the accident happened. This dredge has a composite hull 100 × 39 × 11 ft., of pine planking; all the framing, bucket arm and spuds are of steel. She was built for a 90-ton pull on an 8-yd. bucket, at the maximum depth of 48 ft. of water. She was built under the plans and superintendence of L. A. Desy, A. M. Can. Soc. C. E. The Polson Iron Works will raise the dredge and put her in repair.

THE ELEVATOR ACCIDENT in the Land Title Building, Philadelphia, on Aug. 8 has been reported on by H. Kessler, Acting Chief of the Bureau of Building Inspection, in part as follows:

. . . . . a human agency, intervening, set the [illegible] shank device so that it was necessary that the car should be falling at the rate of 600 ft. per minute before the clutches would work. As the car would not attain that velocity in falling after the breaking of the cable, the clutches could not operate. Had there been a cushion at the foot of the shaft, this accident would have been averted.

It is stated that the device named is now set to operate at a 500-ft. speed.

AN ERASING MACHINE is described in the "Progressive Age," July 1, 1905. An ordinary dental engine, such as dentists use for drilling teeth, was procured and a circular ink eraser was set in the mandrel by means of a small screw instead of the regular drill used by the dentist. Foot power was used for operating it. The flexible shaft to which the eraser is attached allows the draftsman to guide the eraser over the drawing. The machine must be kept at a good speed, and the eraser must not be pressed too hard upon the paper. A good paper will take on a hard surface at the erased place, so that the erasing will scarcely be noticed. In a city engineer's office, maps are frequently changed to show the location of new pipe lines in place of old ones, and a great deal of erasing is done. This machine reduces the labor involved and gives neat results.

RAIL GRINDING MACHINES for smoothing off irregularities in the heads of street railway rails, especially at the joints, are used to some extent in England, and one of these was shown at a recent exhibition of street railway appliances in London by the Railway & General Engineering Co., of Nottingham. A steel underframe is mounted on four small wheels, and carries a frame for carborundum grinding wheels mounted in an adjustable slide rest. The slots of cable and electric conduit railways can also be ground out or milled out if they become too narrow. The machine can be propelled by electric motors or a gas engine.

CALCULATING THE CUBICAL CONTENTS OF PILING.

The accompanying table for calculating the cubical contents of piling is based on the prismoidal formula, and has been prepared by Mr. E. O. Faulkner, manager of the Tie and Timber Department of the Atchison, Topeka & Santa Fe Ry., at Topeka, Kan. The rule for its use is as follows:

Find the diameter of each end of the pile by taking the mean of the longest diameter and the diameter at right angles thereto, in each case working to the nearest half inch. Multiply the tabular number corresponding to the mean large and the mean small diameter of the pile by the length of the pile, in feet; the product is the content of the pile in cubic feet.

TABLE FOR CALCULATING CUBICAL CONTENTS OF PILING.

Large Diam. (ins.)	Small Diameters (ins.). 6	6½	7	7½	8	8½	9	9½	10	10½	11	11½	12	12½	13	Large Diam. (ins.)
8	.27	.29	.31	.33	...	...	...	...	...	...	...	...	...	...	...	8
8½	.29	.31	.33	.35	.37	...	...	...	...	...	...	...	...	...	...	8½
9	.31	.33	.35	.37	.39	.42	...	...	...	...	...	...	...	...	...	9
9½	.33	.35	.37	.40	.42	.44	.47	...	...	...	...	...	...	...	...	9½
10	.36	.38	.40	.42	.44	.47	.49	.52	...	...	...	...	...	...	...	10
10½	.38	.40	.42	.45	.47	.49	.52	.54	.57	...	...	...	...	...	...	10½
11	.41	.43	.45	.47	.50	.52	.55	.57	.60	.63	...	...	...	...	...	11
11½	.43	.45	.48	.50	.52	.55	.58	.60	.63	.66	.69	...	...	...	...	11½
12	.46	.48	.50	.53	.55	.58	.61	.63	.66	.69	.72	.75	...	...	...	12
12½	.49	.51	.53	.56	.58	.61	.64	.66	.69	.72	.75	.78	.82	...	...	12½
13	.52	.54	.56	.59	.61	.64	.67	.69	.72	.75	.79	.82	.85	.89	...	13
13½	.55	.57	.59	.62	.64	.67	.70	.73	.76	.79	.81	.85	.89	.92	.96	13½
14	.58	.60	.62	.65	.68	.70	.73	.76	.79	.82	.86	.89	.92	.96	.99	14
14½	.61	.63	.66	.68	.71	.74	.77	.80	.83	.86	.90	.93	.96	1.00	1.03	14½
15	.64	.66	.69	.72	.74	.77	.80	.83	.86	.90	.93	.96	1.00	1.03	1.07	15
15½	.67	.70	.72	.75	.78	.81	.84	.87	.90	.93	.97	1.00	1.04	1.07	1.11	15½
16	.71	.73	.76	.79	.81	.84	.87	.91	.94	.97	1.01	1.04	1.08	1.11	1.15	16
16½	.74	.77	.79	.82	.85	.88	.91	.94	.98	1.01	1.04	1.08	1.12	1.15	1.19	16½
17	.78	.80	.83	.86	.89	.92	.95	.98	1.02	1.05	1.08	1.12	1.16	1.19	1.23	17
17½	.81	.84	.87	.90	.93	.96	.99	1.02	1.06	1.09	1.13	1.16	1.20	1.24	1.28	17½
18	.85	.88	.91	.94	.97	1.00	1.03	1.06	1.10	1.13	1.17	1.21	1.24	1.28	1.32	18
18½	.89	.92	.95	.98	1.01	1.04	1.07	1.11	1.14	1.18	1.21	1.25	1.29	1.33	1.37	18½
19	.93	.96	.99	1.02	1.05	1.08	1.11	1.15	1.18	1.22	1.26	1.29	1.33	1.37	1.41	19
19½	.97	1.00	1.03	1.06	1.09	1.12	1.16	1.19	1.23	1.26	1.30	1.34	1.38	1.42	1.46	19½
20	1.01	1.04	1.07	1.10	1.13	1.17	1.20	1.24	1.27	1.31	1.35	1.39	1.43	1.47	1.51	20

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ADVERTISING

"Contract": Rates furnished on application.
"For Sale": $1.50 per inch.
"Proposal": $2.40 per inch.
"Want": See pages 26 and 27.

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Entered at the New York Post-Office as Second-Class Matter.

Mr. Butterworth, of Grand Rapids, in an article on winter stoppages of gas service pipes abstracted elsewhere in this issue, has the temerity to say that a public service corporation is under obligations to forestall all known possible grounds of complaints from its consumers, and especially all complaints of stoppages in services or meters. We agree with him that such an ideal should be the standard of water, light and railway companies. Our present purpose, however, is merely to call attention to the main theme of the paper, inasmuch as winter stoppages in gas services may confront other than gas engineers at any time and are likely to present a new problem to engineers in general practise.

An alleged difficulty in retaining engineers in the municipal service of Manila, P. I., is explained by the Manila "Cablenews," by means of the "deadly parallel." That is, it quotes from Engineering News two advertisements of civil service examinations held at about the same time last winter. One was for candidates for civil engineers to fill vacancies in the Philippine service at $1,200 and $1,400 a year, and the other for candidates for positions on the Panama Canal, ranging from assistant civil engineers at $200, $225 and $250 a month, instrument men at $175 and level men at $100 and $125 a month down to chainmen at $60 and helpers at $50 a month. In addition to an offer of much higher pay for a lower grade of positions, the Journal named calls attention to a variety of allowances granted at Panama and not given in the Philippines. We have been asked to comment on the foregoing statements. We do not feel like saying much without more definite information regarding the relative cost of living in the two countries and the class of work demanded of the civil engineers in the Philippines. On the face of it, even $1,400 a year seems remarkably low pay for a civil engineer anywhere; and even after making allowances for some of the possible differences in conditions between Panama and the Philippines and the further possible difference of healthfulness in favor of the Philippines there seems to be justification in the complaint of the low salary said to be offered by the municipal board of Manila.

We have often commented on the difference between intermittent sewage filtration in Great Britain and America. Both the name and the practice originated in England many years ago, but owing to a variety of local conditions which need not be discussed now intermittent filtration in the two countries generally means something quite different: There, it is mostly a rough and ready supplement to sewage farming, to be used in winter and other wet weather at periods during the crop growing season. Here, intermittent filtration is often the sole reliance, or nearly that, of a community; and moreover it frequently gives a high degree of purification and one which on the average is probably far above that obtained at British sewage works not provided with good sewage farms. At least one American on a journey through England has found it difficult, in the course of ordinary conversation with engineers and sewage works managers, to make them clearly understand the American conception and practice of intermittent filtration. In view of the foregoing statements we are pleased to learn from our British exchanges that so able an expounder of sewage treatment in all its phases as Prof. Leonard P. Kinnicut, of the Worcester (Mass.) Polytechnic Institute has but lately read a paper before the Royal Sanitary Institute on "The Intermittent Filtration of Sewage as Practiced in America." We shall await with interest a report of the oral and written discussion of the paper in the Journal of the Institute. The publicity given Dr. Kinnicut's paper at the London Congress of the Institute and in both our British contemporaries and the Journal named will do much to give our British friends a truer conception of sewage treatment in America and may stop some of them from referring so frequently to the Lawrence experiments of the Massachusetts State Board of Health as being without practical value.

The relief of the congestion of street traffic is a serious problem in many cities, and this is especially the case in Chicago, for owing to the steady growth of the city's immense business and to the concentration of industries, warehouses and railway freight stations, the transportation of freight and the handling of the ordinary city traffic on the streets of the business district is attended with numerous delays and difficulties. It has been estimated that the equivalent of 5,000 car loads of freight is carted daily through the business district of Chicago. One or two firms have established warehouses in outlying districts convenient to railway facilities, so as to avoid the transportation of freight through the streets from the railway stations to the city warehouses and then back to other stations for shipment to purchasers. There are two other methods of relieving the street traffic which will provide for existing traffic and establishments by taking a number of wagons and teams off the streets. The first of these is the institution of a transportation system for the handling of mails, newspapers, parcels, coal and general freight in the deep level tunnels which have several times been described in our columns, and which already aggregate 30 miles in length, forming a rectangular network under the business district and extending to outlying points. The lines are of 2 ft gage and are operated by electricity. Having spurs and connections to railway passenger and freight stations, newspaper offices, post offices, warehouses and large store and office buildings, these tunnel lines will provide not only for the handling of freight, but for the delivery of coal and building material, and the removal of ashes and of wreckage and excavated material from building sites. The system is already in use for this last purpose, and has relieved the streets not only from a certain number of wagons, but also from the dirt and nuisance which always attend the handling of such material through city streets. It is expected that this transportation system will be put in operation for general freight and other service before the end of the year. The other method of relieving street traffic is by the utilization of the Chicago River, along which many industries, warehouses, freight terminals, etc., are located. It seems strange that this thoroughfare was not more extensively utilized for local transportation long ago, but the tendency has been to handle the increased traffic in the same old way by simply increasing the number of wagons on the streets. A few steam barges have been run, but now a company has been organized to handle the traffic in a more systematic manner. One result of the recent widespread and protracted strike of the teamsters in Chicago has been to call attention to the possibilities of the river as a transportation route, and some of the large wholesale firms are said to be preparing to operate their own river service by the use of steam canal boats in order to be to some extent independent of the labor element. The boats are low enough to pass under the numerous bridges, and so avoid delays in waiting for the bridges to be opened. They are common steam barges or canal boats, and present nothing of particular interest in either construction or equipment. The tunnel system is of more interest from an engineering point of view, and has a larger range of usefulness. Both the tunnels and the steamboats represent interesting methods of local freight transportation designed to facilitate business and incidentally to relieve the congestion of traffic in city streets.

THE ABUSE OF THE LECTURE METHOD OF TEACHING ENGINEERING SUBJECTS.

An examination of the numerous catalogues of engineering colleges received during the past year discloses the fact that the lecture method of teaching dies a hard death. Thousands of students are still forced to waste much of their time and energy in listening to lectures. We say "waste," not in an absolute sense, but in a relative sense of the term. There is unquestionably some value in sitting for an hour taking notes on almost any theme, but the mental training is slight and the addition to the student's knowledge is meager in proportion to the time spent. We wonder how many lecturers have made comparative time records showing the number of minutes required to read a page of printed matter and the number of minutes required to copy the same page in long hand. For those who have not timed their work in this manner it will be interesting to know that a page which can be read in one minute will require at the very least fifteen minutes of very rapid work to copy in long hand. Therefore, so far as an accumulation of facts or rules of practice is concerned, the lecture system is exceedingly wasteful of time, since by four minutes of reading the student can cover all that he has written in an hour.

Of course it is true that the student's note book contains only a part of what he hears at the lecture—often only a few jottings that he will use as jogs for his memory prior to the next examination. But this very fact is itself a powerful argument against the lecture method of instruction; for it may be safely assumed that a few years after such notes have been taken their value as jogs to the memory is next to nothing and their intrinsic value is absolutely nothing. Many faithful students perceiving this fact intuitively spend hours in elaborating their meager classroom notes for future use. But even they are generally doomed to disappointment so far as the actual future use is concerned. Their notes at the best must be fragmentary, and, in turn, the teacher's lectures are themselves fragments of still other fragments of published information.

Perceiving this to be so, it became the fashion some years ago to furnish the students with carbon copies of lectures. This was an improvement, certainly; but the carbon copies were necessarily on a sort of tissue paper, so flimsy as to be a nuisance to handle, and often so poorly copied as to be illegible or at least very trying upon the eyes. Recently the use of mimeographed notes has become more common; and as they can be printed on heavy paper, and can be made quite distinct, a great improvement has been effected.

We see in these printed notes a natural evolution toward an ultimate breaking away from the method of instruction by lectures. Of course, the only legitimate excuse for mimeographed notes is the lack of a suitable text book on the subject. With the rapid multiplication of books, and the corresponding improvement in the quality of the text and illustrations, the time is fast coming when mimeographed notes will be used only as adjuncts to text book instruction. Indeed, we believe that for many subjects that time has actually arrived, and that many teachers are wasting their own energy and that of their students by following precedent in lecturing with

the aid of carbon copies or mimeographed notes.

It is often said that no one text book contains all that it should contain, or that it contains too much, or that its treatment of the subject is confusing, or what not. We may as well admit at once that no text book on an engineering subject is apt to be wholly satisfactory to anyone but the author—and not always to him after it is out of the press. But the point that we desire to make is this: It is more economical of time to use one or more of the best text books as a basis for any course of instruction than to cast all books aside and prepare a set of lecture notes, whether those notes are given to the students by word of mouth or as leaflets.

There are many professors who are led to lecture, or to prepare leaflet notes, with a view to reducing the cost of an engineering education. The cost of text books is no small item, it is said, and the logical conclusion appears to be: Dispense with books entirely, and thus save the students undue expense. In fact, this is the most illogical of conclusions. If a student were to copy the contents of a 300-page book, it would take him about 4,500 minutes or 75 hours. Were he to work these 75 hours as a common laborer, he could earn $11.25, or about three times the net price of the ordinary 300-page book, and incidentally he would be building up his muscles.

There is, therefore, no economy in replacing books by word of mouth lectures. Against mimeographed notes this same reasoning does not hold, for the instructor then does the labor, and the student is given the results of this labor in a form ready for use. When all the lectures are given out in this form, the student is really supplied with a home-made text book, and the question then becomes largely one of economy in preparing and making the leaflets.

However, one of the most serious objections to a home-made text book of this kind is the expense of preparing suitable illustrations. Due to this expense it is customary to use comparatively few illustrations with mimeographed notes—often to the serious detriment of the home-made book. Another objection is the lack of binding. Where a lot of unbound notes are owned by an engineer we believe it to be the common experience that they are seldom used after graduation. This is due not only to the inconvenience of seeking information in them, but to the fact that they are not safely kept in book shelves or on the desk. Moreover, they are seldom indexed, and their value as reference books is thereby greatly reduced.

We fear that because of the present tendency to instruct students only with a view to mental training a very important fact has been somewhat overlooked, namely, a large part of an engineer's knowledge consists in knowing where and how to find data and information. One of the great merits of text book instruction consists in supplying the young engineer with a nucleus of facts with which he becomes so familiar that in after life his good old text books are often more serviceable to him than many of the newer and intrinsically better books. The young graduate's library of engineering books is meager enough at best, but if this library is reduced to a few books on mathematics and a huge pile of notes, unbound and without indexes, and often unillustrated, the young engineer is sadly handicapped at the very start.

Then, too, there is another danger in using lectures extensively, except as supplements to text book instruction. The student is led to suppose that his notes are the cream of knowledge on the particular subject in question—for has not the instructor spent years of his life gathering only the very best of information from all sources? The truth is, and the instructor himself would be the first to admit it, that lectures are given principally to drive home principles and to lead the student to think for himself. They seldom contain enough details to be of value as sources of subsequent information in actual designing. This in turn gives the student a wrong conception of the work of an engineer. He hears so much of principles and of mental training that he comes to have a reverence for generalities and a sort of contempt for details. If he knows the principle governing the calculation or the design he is satisfied with himself. The thousand and one little details, which in the aggregate go to make a good design, are somewhat beneath his view of things. He is also apt to be careless in his subsequent attention to details, and is given to evolving them out of his own brain, regardless of whether or not some other engineer has designed the same detail before and in better form.

The practical man, on the other hand, has a great reverence for precedent. He wishes to see how some one else has solved a problem. But the young engineer whose brain is fed upon principles and who prides himself on his mental training, is likely to be altogether too self sufficient. He has not learned the value of precedent as a guide to action. Now, it is well that a man be self reliant, but it is not well that he be too self reliant, particularly at an early period in his career. After the super-confident young man has made a few serious blunders, the reaction in his feelings is apt to carry him to the extreme of conservatism. He may then become more a worshipper of precedent than the practical man.

What has this to do with lecture instruction? Our answer is that lectures are apt to consist of principles largely, and are weak in detailed accounts of actual structures and methods. If they are not weak in this respect, then they duplicate to great extent what already exists in books. Lectures being, as a rule, the "cream of information" leave an insufficient amount of work for the student in digging out his own knowledge from books and other sources. He is not trained in the best method finding information—this is all done for him by the lecturer; and often the lecturer fails to tell where he secured his own data, so that the student is still further handicapped. Lectures stimulate the mind, but they do not furnish something resistant for the mind to work upon. They attempt to do for the student that which he should do for himself. They are enervating and wasteful of time. There is, and always will be, a use for lectures. They are especially useful as mental stimulants. A good lecture is better than a glass of wine. Not only does it excite the brain of the listener, but it does not leave him less fit for action as an alcoholic stimulant does. Moreover, its effect is enduring; indeed, it may last for a lifetime and influence the listener's mental growth to an extent immeasurable. It is the rain upon the seed—but there can be too much rain.

Lectures, then, are properly given at intervals, and only by those who have the gift of arousing enthusiasm in their subjects. Lecture notes, in mimeographed or other form, may be used liberally as supplements to the best text books available. If the text books are long on practical details and short on fundamental principles, let the lecture notes supply the deficiency. If the text book is short on details and data, again let the lecture notes fill the gap not only by giving actual data but by references to journals and transactions.

In a word, books should be used as adjuncts in solving problems in the office, in the laboratory and in the field; printed lecture notes should be used as adjuncts to the books; and verbal lectures should be used as adjuncts to instruction in all the subjects, by exciting an interest in each subject and maintaining the interest until the subject is mastered.

LETTERS TO THE EDITOR.

Labor Distribution Accounts, Maintenance of Way Department, Richmond, Fredericksburg & Potomac R. R.

Sir: In connection with the editorial on the subject of "Railway Maintenance of Way Expenses" in your issue of July 27, 1905, I would like to call your attention to the system of labor distribution accounts for office record used on the Richmond, Fredericksburg & Potomac R. R. (Washington Southern Ry. since January, 1904). The system is simply an elaboration of the one that has been in use for a number of years on this railroad, and adapted to the classification of operating expenses as prescribed by the Interstate Commerce Commission, which I arranged while connected with the maintenance of way department of the road. The scheme is as follows:

Maintenance of Way Office Record of Labor Distribution.

I. MAINTENANCE OF WAY AND STRUCTURES.
(1) Repairs of Roadway: (a) Building up Roadbed. (b) Ditching in Cuts. (c) Ditching Outside of Cuts. (d) Cutting and Burning Brush on Right of Way. (e) Removing Grass and Weeds on Roadbed. (f) Ballast Renewal. (g) Putting in Ties. (h) Laying New Rail. (i) Track. (i) General Surfacing Track. (j) Surfacing Joints. (k) Applying Track Material. (l) Work on Sidings. (m) Clearing Snow and Ice. (n) Trackwalkers and Watchmen. (o) Interlocking Plants and Signals. (p) Clerks and Roadmasters.
(3) Renewal of Ties: (a) Inspection.
(4) Repairs and Renewals of Bridges and Culverts: (a) Material Inspection and Handling. (b) Carpentry and Labor. (c) Watchmen and Drawtenders.
(5) Repairs and Renewals of Fences, Road Crossings, Signs and Cattle Guards: (a) Passenger Buildings. (b) Freight Buildings. (c) Roadway Buildings. (d) Signal and Telegraph Offices. (e) Tanks and Water Supply.

There is no difficulty in keeping a close watch upon the monthly expenditures; explanations of increase or decrease can be readily made and costs of particular pieces of work easily determined. I found that there was less difficulty in keeping this report up by the section foremen than the more condensed forms used by most roads, principally because the foremen could understand the classes of work enumerated. Yours truly,

J. H. Eby.

Ashland, Va., Aug. 8, 1905.

Further Comments on Graft in Engineering.

Sir: Referring to the letters in your issue of Aug. 3, 1905, on Graft in Engineering, "Engineers" and "Railroad Engineer" deserve all credit for their position on the subject of "graft," and all encouragement in their endeavor to remain uncorrupted. Nevertheless, I cannot see that the circular letter which you reprinted is in any sense an offer of a bribe, or that the manufacturer seeks to invade the province of the consulting engineer. Engineers and others who buy supplies must of course consult freely the manufacturer, his salesman or engineer, just as they would refer to a trade catalogue; and the information so acquired is no more a bribe in one case than in the other.

In this case the manufacturer invites his customers to consult him freely, and the writer believes that the customers will do so without feeling that they are being corrupted in the least. Very truly yours,

A. B. I.

Washington, D. C., Aug. 8, 1905.

(The circular mentioned just above consisted of an out-and-out offer of free engineering advice on matters pertaining to several lines of engineering supplies. Doubtless there are many cases where such advice could be asked by an engineer without prejudice to his client; as, for instance, when he had already concluded to specify or recommend the goods of the firm offering the free advice, and wished to know what size, capacity or style of those goods was best suited to the work in hand. But in hundreds of instances the engineer who accepts such offers of free advice does so to the prejudice of all the goods of other manufacturers in the same line. In such cases why should not the engineer's client dispense with the services of the latter, deal directly with the manufacturer and himself obtain the advantages of free engineering services?—Ed.)

Sir: I enclose an advertisement received to-day which I send you to use in connection with the discussion of "graft" now appearing in your columns. This circular is addressed to the company for which I am superintendent, and the watch offered in the circular is to be given to the signer of the blank form, be he purchasing agent, superintendent or otherwise. Of course, the company would eventually pay for the watch.

Yours truly, Superintendent.

Tecumseh, Ala., Aug. 6, 1905.

(An imitation-typewritten letter and a four-colored printed circular accompanied Superintendent's letter. In return for signing the "enclosed agreement" the signer is to be given an "Elgin 20 year, Solid Gold Filled Watch." The signer agrees to receive, on 30 days' approval, a 60-lb. drum of belt dressing, billed at 35 cts. per lb. If the watch and the dressing are not satisfactory to the signer he is authorized to return both at the expense of the manufacturer of the belting; if both are satisfactory the signer is to pay the bill for the dressing within 60 days, and he is also "to observe results closely and if the dressing proves as" the manufacturer states the signer is "to recommend it to" his "friends where occasion presents itself." It is only fair to call attention to the fact, for what it is worth, that the circular letter forwarded to us was addressed to a company and not to an officer of a company.—Ed.)

Sir: Apropos your communications and comments on "graft" in your issue of Aug. 3, it seems opportune to

note another phase that should be frowned down. That is the tendency for engineers to act as commercial agents or representatives for manufacturing companies and supply houses, while at the same time undertaking to do, and so advertising, a general consulting business. In this capacity they often furnish designs and specifications free of charge and expect their commission on goods sold to cover the expense of preparing such. In such cases it

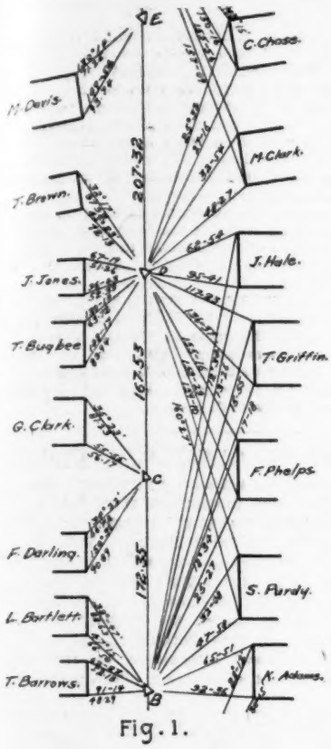


Fig. 1.

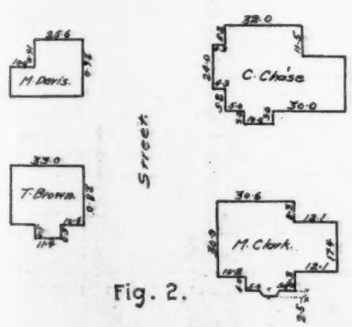


Fig. 2.

is easily seen how the clients' interest may be subverted to the interest of the supply house or manufacturing company. A consulting engineer should be free from bias and should get his remuneration direct and only from the client whom he serves.

Engineers should wholly be on the professional side or on the commercial side. There should be no attempt to combine the two antagonistic interests. The general standing of the profession will be higher if there is a sharp line drawn between the strictly professional engineer and the commercial engineer. Each has his proper sphere of activity.

The writer would like to hear from other engineers on this subject.

Yours truly,

Professional.

Kansas City, Mo., Aug. 9, 1905.

Suggestions on Surveys for Mapping the Location of Buildings on City Streets.

Sir: Replying to T. R. Ansit's request for suggestions in regard to methods for mapping the location of buildings in city streets (Eng. News, Aug. 3, 1905), the writer desires to submit the following outline of two methods that were used by him in the survey of several miles of streets in a city having a population of about 10,000. Both methods give accurate results, and the notes are easily recorded and plotted.

The first method is especially useful when the street is comparatively narrow and the houses close to the sidewalk; it consists of locating the two front corners of each building by means of angles from a base line and distances from the transit, as represented on the left side of the base line in Fig. 1. The transit is first set up at a convenient point on the base line, preferably the center-line of the street, the vernier made to read zero, and the telescope sighted along the base line by means of the lower tangent screw. While in this position several points are located along the base line about 200 feet apart for future transit points. When this has been done the upper tangent screw is loosened and the telescope pointed at a corner of a house that is to be located; the angle indicated by the vernier between the telescope and the base line, and the distance from the transit to the observed point are then recorded in the note-book. This operation is repeated until the angle and distance to each desired point within a radius of 100 ft. from the transit have been recorded. Then the transit is moved to the next point where the operations are repeated for all points within a radius of 100 ft. from this point. In like manner fences, trees, edges of lawns, hydrants, etc., may be accurately located, if desired, and easily plotted on the map.

When the street is very wide and the houses are located quite a distance back of the sidewalks, many points will be outside of the 100 ft. radius referred to above, and as the distance from these points to the transit can not be measured directly by a 100-ft. tape as in the method outlined above some other method is preferable. In this case each point is located by means of two angles from the base line as represented in the right side of Fig. 1. The transit points are usually taken from 200 to 400 ft. apart. When the transit is at a station the angles between the telescope and the base line are recorded for all points from the station behind to the station ahead of the one occupied by the transit, and the instrument is then moved to the next station where the same operations are performed.

The angles may be read in one direction from 0° to 360°, in two directions from 0° to 180°, or in four directions from 0° to 90°. This will depend to some extent upon the manner in which the graduated circle is divided, due regard being paid to the type of protractor that is to be used in plotting. The protractor used by the writer was a complete circle graduated in both directions from 0° to 180°, so he recorded his angles in this way as represented in Fig. 1; the angle marked upon any line being the angle between that line and the portion of the base line ahead of the instrument.

If, in addition to the fronts of the buildings it is desired to locate the entire outline or ground plan, it is necessary to measure the length of several sides of the building. For this purpose the outline of each house is sketched in the note-books, as represented in Fig. 2, and the lengths of a sufficient number of sides are measured. As the front line has already been located by the transit it is unnecessary to measure the length of this side, but on account of the excellent check it affords it is desirable to do so. It is customary to assume that the corners of houses are right angles and the walls parallel; if a corner is obviously not a right angle then three or more corners, instead of two, are located by the transit.

In Fig. 1 the buildings on the left hand side were level with the street and close to the sidewalk so the method of angles and distances was used. The buildings on the right hand side were on high terraces and at a considerable distance from the sidewalk so the method of intersecting lines was used; it was found advisable in this case to turn angles to the right from every other station only.

If the party is properly organized and works systematically this work can be carried on very rapidly. For greatest rapidity and economy the party should consist of three men, viz.: note-keeper, transitman and rodman. While the transitman is setting up the instrument and arranging the vernier, the rodman proceeds to the point ahead to give the line and the note-keeper sketches in the note-book all the points that come in range of that station, lettering the houses in the note-book with the owner's name, if possible, to facilitate reference.

Charles E. Smith.

1319 Pine St., Scranton, Pa., August 5, 1905.

Sir: In reply to the inquiry by T. R. Ansit in your issue of Aug. 3, I am enclosing a hasty sketch (Fig. 3) of a method used on quite an extensive survey with which I was connected and which we found more satisfactory than any other method.

I will assume that a base line has been laid out and marked every 100 ft.; set up transit on each 100 ft. station and turn a right angle across the street; with an ordinary carpenter's chalk line snap in the base line, the right angle lines and on the opposite sidewalk from the base line an auxiliary base line parallel to the original and at some even and convenient distance from it (in the sketch I have assumed 50 ft.) Two men can now take a 100 ft. steel tape and measure building corners and other objects from these chalk lines recording the measurements in white chalk directly on the object and in the form of a fraction as will be noted on the sketch. In these fractions the numerator records the distance ahead of the last 100 ft. chalk line and the denominator the distance from the base line. It is advisable in measuring to do all the measuring in one direction between stations before taking the right angle distances, as by so doing considerable time can be saved and the tape does not have to be handled so much. By way of a check the distances along the faces of the buildings should be recorded also. In locating buildings it will be sufficient to locate two or three points on the building by means of co-ordinates and take dimensions for the balance.

In recording the notes a small celluloid triangle and a 3-in. engineer's scale will be found convenient. Lay out a red ink line on the page of your note-book to represent the base line, mark the stations in to some convenient scale with Roman numerals so that they will not be mixed up with the data. The men who are measuring will in the meantime have gotten a start, and the recorder can now follow them up plotting the notes roughly to scale and putting down the data as indicated on the sketch. Keep the fractions between the point to which they refer and the base line, and keep all dimensions inside of the figure representing the object, these rules are only for the sake of system and will be found to facilitate the work of the draftsman when he comes to plot up the notes. In some instances a few diagonal ties will be found useful, but avoid them as much as possible, because too many of them tend to jumble the notes and confuse the draftsman.

By this system with three men in a party from 250 to 300 ft., in a densely built up city with numerous objects in the street can easily be gone over in a day of seven hours, and I have known of as high as 400 ft. being done in the same time in the busiest streets of New York and Brooklyn. In a sparsely built up section three or four times as much ground can easily be covered.

Yours truly, Tyrrell B. Shertzer.

621 West 152d St., New York City, Aug. 8, 1905.

Sir: T. R. Ansit asks for suggestions for the best and most accurate method of taking measurements for the location of building on city streets so as to plot them easily and readily. The accompanying map (Fig. 4) shows the method I follow in doing such work; although it is an old method I find it accurate and entirely satisfactory.

With the transit run a base line A-B parallel to and back from the street line far enough to clear all fences and hedges. Along this base line, measuring from some known point (in this case the cross street line), lay off

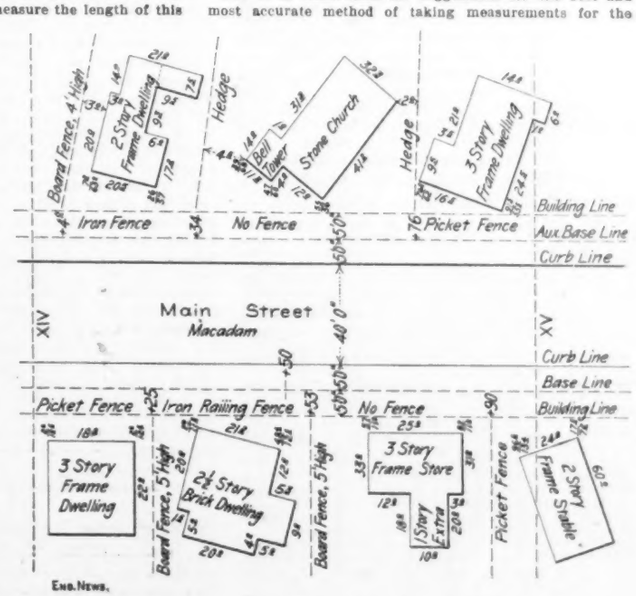


Fig. 3.

stations near the corners of the buildings, and take measurements to these corners (shown on map marked d). Next take dimensions of the buildings and for checks take measurements between rear corners, as shown by c. The base line may be run in the rear of the buildings, and in case out buildings are to be plotted the same base line can be used for both.

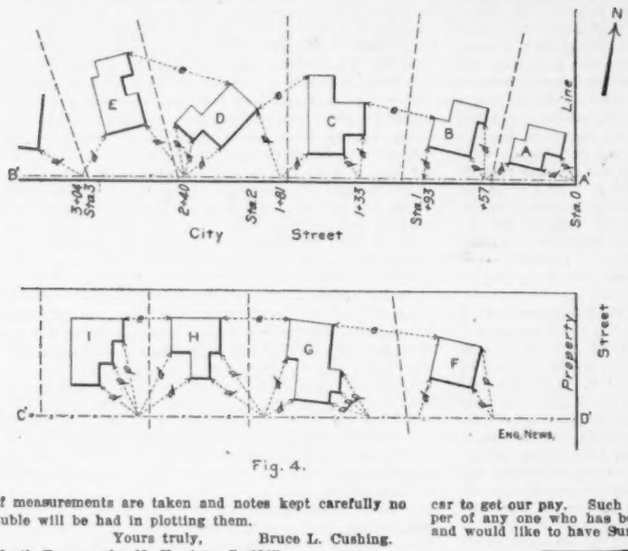


Fig. 4.

If measurements are taken and notes kept carefully no trouble will be had in plotting them.

Yours truly, Bruce L. Cushing.

North Tonawanda, N. Y., Aug. 5, 1905.

A Young Engineer's Optimistic View of Conditions on the Panama Canal.

Sir: I send you herewith a clipping from the local morning paper of Madison, Wis., "The Democrat," containing a copy of a letter written July 14 from a young engineer employed on the Panama Canal. This letter was written to his father by Max King, who was a member of the senior class in civil engineering at the University of Wisconsin last session and went to Panama early last spring. The letter was evidently written without any thought that it would be published, and gives a view of the situation on the Isthmus much more creditable to the way that things are managed there than most of the croakings that have been seen in the public press.

This young engineer is the son of a man who has held important positions in universities as well as under the Government, and was reared in what would seem to most of the men employed on the Isthmus, a home of luxury. If this young man stepped right out of his luxurious university life and found things endurable on the Isthmus in the occupancy of a subordinate position which he secured himself and on his own merit it would seem that there have been unpleasant examples of lack of "grit" in some of those who have raised their complaints in the public press.

Yours truly, W. D. Taylor,

Professor of Railway Engineering.

University of Wisconsin, Madison, Wis., Aug. 7, 1905.

(Portions of Mr. King's letter follow.—Ed.)

I was very glad to get those clippings about Mr. Wallace, as the information here has been very scarce. . . . . .

I have been taking topography all this week, but as the country that we have been trying to cover is a dense jungle and we have only been able to get six men to cut troches we have not gotten over a great deal of ground. There does not seem to be much system to the work that has been done here, as the territory that we are covering has been partly covered before, but the work done has never been plotted and no one knows where the notes are that were taken. The result is that we have had to do the same work over again. . . . . .

There is nothing it seems to me bad enough for anyone who would write such an article as the one you sent about the condition of things here. These articles are written by men who have for some reason been fired and who have therefore gone back to the states mad at everybody and everything. Most of these men are drunkards, and there are a lot of them down here. I don't know as I told you about the old Irishman who came down on the boat with me. He was a track foreman and during the time that he was here (two months) he had 12 track supervisors over him and they were all dropped for drunkenness and incompetency. Of course such men are blacklisted and cannot get other work from the commission or the Panama railroad. Now, these men go back to the states or die of drunkenness. There is no truth in the statement that the men are not well taken care of down here, for, as far as medical services and hospital accommodations are concerned, nothing more could be asked. I have talked with a number of the men, both black and white, and they all say that the treatment at Ancon is all that could be desired. The hospital is crowded but not so much so that anyone has to be turned away. As for not having a bed to sleep on, that is very likely true, but I, for one, would rather have a canvas cot to sleep on for the reason that it does not get musty. They are very comfortable except when your joints are full of malaria, and then they seem as if the cots were made of boards instead of canvas. As for a pillow, I have not slept on a pillow since I left the steamer, but it is not because I could not get one if I felt like buying one from the commissary. But when I first came I did not get one and so got used to sleeping without one and now do not feel the need of one at all. It is true that it is very hard to get furniture, such as chairs and tables, but then, what should one expect? We are not working in a place where all the modern conveniences can be had for the asking, so why should we complain if we are put to such slight inconveniences as having to sit on a box and sleep on a cot instead of a feather bed? . . . .

As for myself I feel very good and have no kick coming at all. And I do not think there are many down here who have a right to complain. There are men who come down here on political pull, and so get jobs in the track department, because that department pays better than any other. These men find that they are both expected to know something and also to work, which is not what they came for, and the result is that when they get to the states they write such articles as you sent me; but why a paper of any standing will publish such lies is more than I can see.

Sunday we got our pay for June at last. The notice put up in the office Saturday night read: "The silver rolls will be paid at the Cuebra Y and possibly the gold rolls." Now, that is just a sample of the way business is done here. As it was, we went over to Cuebra at 8.30 and stood in line, first in the sun and then in the rain, until half-past twelve before we got a chance to get into the pay car to get our pay. Such things do not improve the temper of any one who has been working hard all the week and would like to have Sunday to rest in. . . . .

GRAFT IN MINE EQUIPMENT.

The letters on graft in engineering published in our issue of Aug. 3 and in our present issue give added interest to an article in the "Mining and Scientific Press" (San Francisco) of Aug. 5. The article tends to show that graft is confined to no one line of engineering, and that it is practiced on a large scale in the mining field. This field, we may add, seems to lend itself to the ready practice of graft, owing to the frequent location of plants at remote points and to the fact that a large proportion of the stockholders and directors of mining companies have little or no knowledge of the details of the business. The article mentioned is as follows:

Mines are frequently equipped with expensive hoisting and metallurgical plants which are either wholly out of proportion with the available resources of the mine, or entirely unsuited to the treatment of the ore. Not uncommonly the owners and directors of mines and mining companies have little or no knowledge of the business of practical mining, and still less of metallurgical plants and their operation. Such men are likely to build a smelter on a dry ore mine, or put in a gold mill to treat lead carbonate ores because they carry gold. From necessity, where the directorate of a mining company realizes its lack of technical knowledge, they naturally turn to the consulting mining engineer for advice and assistance in preparing proper plans and specifications for a suitable mining and reduction plant. In this engineer they must have implicit confidence, or his services would not be sought, but unfortunately the history of some mining concerns proves that occasionally this confidence is misplaced, and that the "consulting engineer" employed is either grossly incompetent and inexperienced, or that he is a "grafter," and sometimes both. On the other hand, the engineer may be competent, but easily influenced, and, desirous of securing a retainer, lends himself to the plans of another, and recommends what he knows to be unsuited to the requirements of the case, or, at least, that which he is not sure will be entirely satisfactory, trusting to some future turn of fortune's wheel for an opportunity to set himself right—in other words, he embraces an opportunity to experiment at the expense of his client.

In the manufacture and installation of mining equipment, there is often large profit, particularly where the plant is extensive and the competition is not too keen, and substantial proofs of the friendship existing between the manufacturer fortunate enough to secure a good fat contract and the engineer who advises the purchase may sometimes pass. This practice, not at all uncommon in other industrial lines, has resulted in its abuse by some.

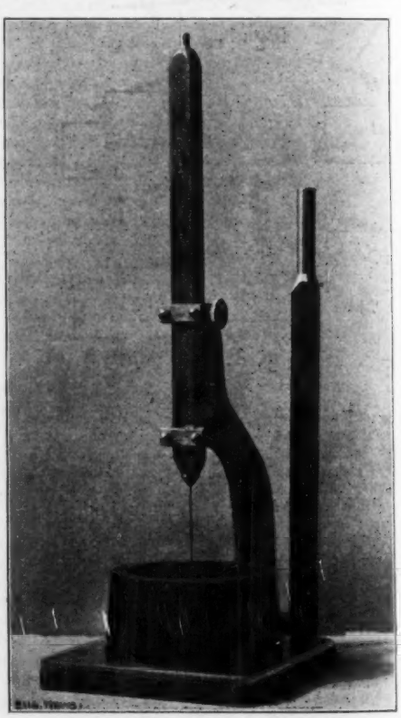
Take as an instance a mining company owning a valuable property, the ore of which is not free milling, but which really requires considerable chemical and metallurgical knowledge on the part of the consulting engineer, who is called in in an advisory capacity, to determine just what sort of plant would be best suited to the reduction of this ore, assuming the ore to be a sulphide, with several bases, but carrying also good values in gold and silver. The engineer advises a stamp mill and an elaborate lixiviation plant. The specifications are elaborate, and set forth in detail each part of the machinery and specify certain makes of mechanical devices which may run up the cost unnecessarily. The investment required in this plant would be large, but the possible commissions coming to the engineer would help to sooth his conscience, even though the entire plant must later on be changed and remodeled at great expense to suit it to the treatment of the ore.

Such grafting cannot but prove injurious to legitimate mining. To avoid such results, the investors should know that their engineer is competent to advise them properly, for in all probability there would be just as much advantage to the engineer in advising a proper plant in the first place as in that which ultimately proves to be useless for the purpose for which it was intended. Many large plants, it would seem, are ordered on insufficient investigation as to their adaptability to the ore to be treated and to surrounding conditions.

In one instance, the purchasing agent of an Eastern corporation owning mines in the West made a request for bids on a plant of certain description. The engineer for the house assured the would-be purchaser that the plant proposed was not at all suited to the ore, but was told bluntly that it need not concern him in the least; that the company had decided to build a plant of that description, and if this house did not care to furnish it they would go to those less particular. As the machinery people were out for business, they took the contract and built the plant, but as had been said, it was not adapted to the ore and it stands idle to-day.

AN IMPROVED FORM OF VICAT NEEDLE APPARATUS.

An important essential of any testing apparatus that is widely used in commercial work is that it shall be so simple that it is impossible or difficult for the operator to err in its use. This is particularly true of such an instrument as the Vicat needle, which is used almost continuously in a busy cement testing laboratory. In the ordinary forms of this apparatus the "piston" and the "needle" are separate interchangeable pieces, which are attached alternately to the same plunger bar by a thumb-screw. The needle and



Improved Form of Vicat Needle Apparatus for Cement-Testing Laboratories.

piston, of course, vary in weight, and since the weight of the plunger bar and its attached needle or piston must remain constant at 300 grammes, the variation noted must be provided for by placing suitable weights on the bar. It is a common error in rapid operation to forget to make this change of weights when the needle is substituted for the piston or vice versa. To avoid this chance

of false records the improved form of Vicat needle apparatus shown in the accompanying engraving has been devised by Mr. Joseph W. Bramwell, of Philadelphia, Pa.

As will be seen the improved apparatus has two separate bars, each weighing 300 grammes, one fitted with a "piston" and the other with the needle. The scale to determine penetration is marked on the bars and is read from a fixed pointer on the lower guide. The bars are also provided with stops to prevent them from falling and bending or otherwise damaging the needle. In addition to the advantage which this apparatus possesses in respect to avoiding the error noted above, it has few and simple parts that are easily kept in order.

CONCRETE TIES ON THE LAKE SHORE & MICHIGAN SOUTHERN RY.

Ties of reinforced concrete are in service on several railways in this country, and probably the most extensive use of these at the present time is on the Lake Shore & Michigan Southern Ry., which has nearly 3,000 in the track. Reports have recently been circulating through the daily press to the effect that these ties have proved failures, the concrete disintegrating under traffic. On inquiry, however, we learn (as we had expected) that there has been no such general failure as reported. We quote the following statement made by Mr. Samuel Rockwell, Assistant Chief Engineer, in reply to our inquiry:

We have been experimenting for 3 or 4 years with the tie patented by Mr. C. Buhrer, one of our roadmasters. It consists of a piece of rail turned upside down and imbedded in concrete, the bottom of it is shaped somewhat to the size of an ordinary wooden tie. Practically the only ones of these ties that have failed at all are some which were laid as joint ties or single ties with some 7 or 8 wooden ties between them. Whether by reason of the harder pound at the joints or their rigidity over the wooden ties some of these have split; but of the ties laid to a face, of which we have several thousand in use, we have had practically no signs of trouble so far. It is a fact to be sure that some of these ties were made from gravel which had some stones in it that slaked and burst open some of the thinner portions of the concrete alongside of the web of the rail, but this was no fault of the tie. It is but fair to add that I have by no means lost faith in these concrete ties and am making more of them this year.

The ties in question are of the pattern invented by Mr. C. Buhrer, Roadmaster of the Lake Shore & Michigan Southern Ry. at Sandusky, O. The design is shown in the accompanying cut, and it will be seen that the reinforcement consists of a length of 65-lb. scrap rail, inverted; the flange forms the seat for the track rail and the attachment for the fastenings. It is proposed, however, to use a rolled section which will weigh about 80 lbs. The ties as now made weigh about 400 lbs. (concrete, 235 lbs.; steel, 165 lbs.) In some of the ties the concrete proportions are 1 part cement to 4 parts gravel; others have 1 part cement, 1 part fine washed limestone, and 3 parts ½-in. washed limestone. The labor, cement, gravel and stone cost about 50 cts. per tie, but with machine mixing and machine pressing it is thought that the cost for labor could be reduced to about 8 or 10 cents per tie. The cost of the scrap rail depends upon its market value. Besides ties which have failed on this railway, there have been some failures on the Pennsylvania Lines, where the ties were placed in the westbound main track on a 6° curve. Other Buhrer ties on the same road, near Toledo, are giving good service. Over 5,000 of these ties have been made, and 4,200 are in use, as follows:

Lake Shore & Michigan Southern Ry. (Elkhart Div., 1,000; Old road, 1,003; Sandusky Div., 710; Chicago Div., 230)..	2,943
Pennsylvania Lines	450
Lakeside & Marblehead Ry.	550
Sandusky City water-works track..	120
Ann Arbor Ry.	77
Lake Erie & Western Ry.	24
Wabash Ry.	25
Chicago & Northwestern Ry.	15
Total in use	4,204
Made, but not yet in use	1,000
Total	5,204

SOME NOTES ON THE DEVELOPMENT OF EYE-BAR MANUFACTURE.

By Joseph H. Springer, Sr.*

Prior to 1862 there were few iron bridges in the United States, and those of which we have any record were of short span. The first solid forged eye-bars of which the writer has knowledge were made at the mill and forge of Andrew Kloman, located at the foot of 28th St., in Pittsburg, Pa. The full firm name was Kloman, Phipps & Co., and the plant which the firm operated was the nucleus of the great Carnegie steel works of after years. The story of their first eye-bar work is as follows:

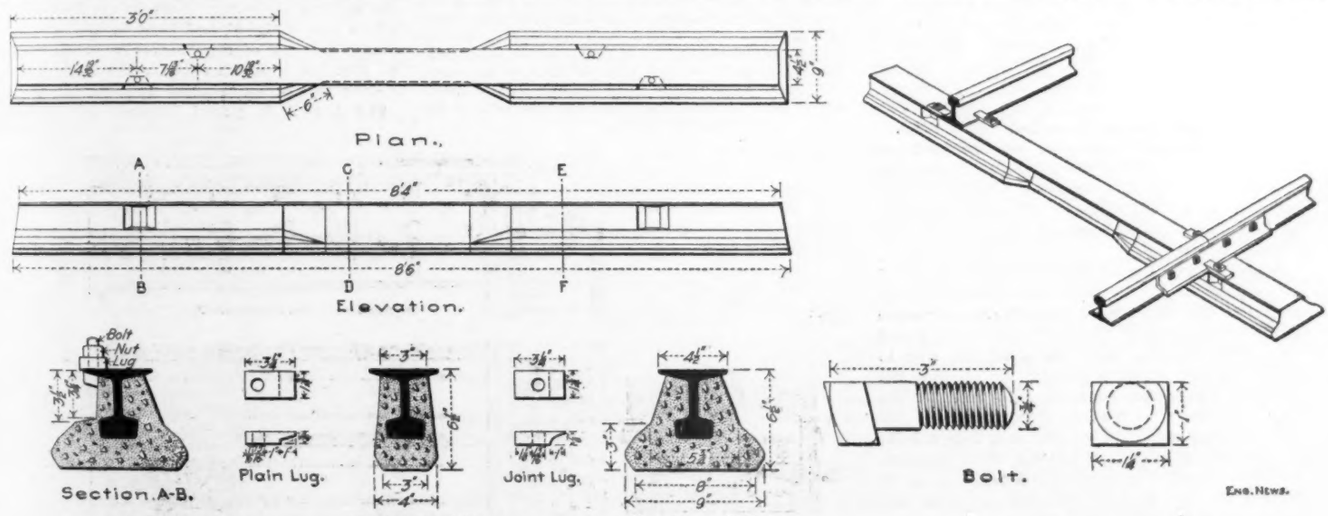
In 1862 or 1863, Mr. Piper and Mr. Shiffler, two wooden bridge builders working for the Pennsylvania R. R., organized a bridge company under the firm name of Piper, Shiffler & Co. The plant of the new concern was located on 28th St. about opposite that of Kloman, Phipps & Co. Mr. J. H. Linville, then Chief Engineer of the Pennsylvania R. R., was interested in the firm of Piper, Shiffler & Co. At that time the Pennsylvania R. R. was building what was called the connecting line from Philadelphia to Jersey City by the way of Trenton. A bridge of several spans was required to take the new road across the Schuylkill River, and there were also a number of single span structures crossing streets and other railway lines within the Philadelphia city limits. These bridges were all designed by Mr. Linville. They were pin-connected structures with cast iron top chords and end posts, eye-bar bottom chords and wrought iron verticals with cast iron end connections. The writer, who then had a small iron foundry and machine shop in Philadelphia, called on Mr. Linville for drawings and specifications in order to bid on the work but was frankly told that the work would go to Piper, Shiffler & Co. This it did, and when the work was in the shops of that company, the writer was in Pittsburg and visited both Kloman, Phipps & Co. and Piper, Shiffler & Co. The eye-bars were being forged in Kloman, Phipps & Co.'s shops.

Mr. Kloman had in his forge two large helve hammers mounted on large oak timbers and operated by vertical steam cylinders about 24 ins. in diameter; he used these hammers for forging car axles. To make the eye-bar he had a crude upsetting machine mounted on timbers, with a crude wedge device to hold down the bar and a hydraulic cylinder at one end to do the upsetting. The bars came from this machine looking like a letter S, and while hot were flattened out under the helve hammer. The processes of upsetting and flattening were repeated until there was stock enough upset to form the heads. The final work of the hammers was to flatten out the heads to the same thickness as the body of the bar. In this shape the bars were taken over by Piper, Shiffler & Co., and the heads lined off and "trimmed" in a smith forge. About ten or twelve bars were made in ten hours.

About 1864-5, the Phoenix Iron Co had a more modern plant for upsetting and die-forging eye-bars made by William Sellers & Co. This worked much better than did Kloman's crude plant. A few years later, about 1872-73, the Edge Moor Iron Co. was organized by William Sellers and his brother, and built a bridge works on the Delaware River near Wilmington, Del. The new plant was fitted up with a large, well-designed plant for making eye-bars. The upsetting would, however, leave the neck of the eye-bar wrinkled for about 6 to 8 ins. In the Spring of 1875 the writer was employed by the Edge Moor Iron Co. as Shop Superintendent, and remained with the firm three years, during which time the famous Kentucky River Viaduct was built. By means of a change in the dies, he stopped the wrinkling of the neck during upsetting.

Late in the '69z the firm of Piper, Shiffler & Co. was reorganized as a stock company and the firm was named the Keystone Bridge Co. This company built the great steel arch bridge over the Mississippi River at St. Louis, Mo. In the spring of 1878, Mr. Piper and Mr. Shif-

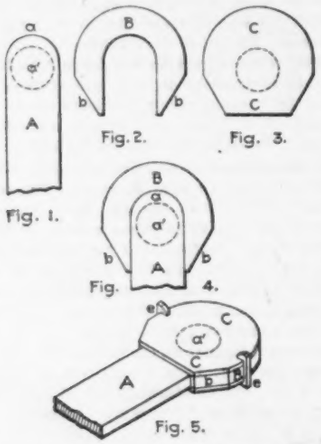
*Galt House, Louisville, Ky.



CONCRETE TIE; LAKE SHORE & MICHIGAN SOUTHERN RY.
C. Buhrer, Sandusky, O., Inventor.

fier retired from the management of the Keystone Bridge Co., and Mr. A. Gottlieb was elected President and the writer was appointed General Superintendent. The company was composed of Mr. Andrew Carnegie and a number of his associates. Upon joining the Keystone works, the writer found the two old helve hammers he had seen years before in Kloman's forge. The Keystone company had used these machines for five or six years without a change in practice except to mill off the extra material in the heads.

The demand for bridges of longer span grew rapidly about 1874-5, and much heavier eye-bars were required. There were only a few shops that engineers would ask to bid on this class of work and the Keystone Bridge Co. headed the list. This company in the fall of 1878 secured contracts for the majority of the bridges and viaducts on the Cincinnati Southern Ry., as well as a number of miscellaneous contracts which increased the working force to about 1,200 men. The writer was compelled to use the old Kloman eye-bar plant for a few months, and then a 3½-ton vertical hammer for die forging was installed with a modern gas furnace attached. Two 1,500-lb. hammers for small bars were also installed and plans prepared for a large hydraulic upsetting machine. In the meantime the writer had patented in the United States in 1879 and in Canada in 1882 a process for making eye-bars which is described later.



Figs. 1 to 5. Diagrams Showing Method of Manufacturing Eye-Bar Heads by Welding Piling Pieces to Bar.

When the new 3½-ton hammer was installed at Keystone, one of the old helve hammers was placed so that it could be reached as soon as the bar was taken from the upsetting machine and also from the die. The object of this was to work the bar after upsetting to remove the wrinkles and after die forging to finish it off. This was the same method that the writer had used at Edge Moor. In the spring of 1879 a 5-ton steam hammer and gas furnace were installed, and the second helve hammer located so as to receive the bars from it. The old upsetting machine was sent to the scrap pile.

From the Fall of 1879 up to the time when open hearth steel replaced wrought iron, the eye-bars for all the structures built by the Keystone Bridge Co. were made by the process known as Springer's patent piling process. Among these structures were the St. Paul St. Bridge at Baltimore, Md., with bars ranging from 4 × ⅝ ins. to 9 × 2 1-16 ins., and the anchor bars for the Brooklyn Bridge cables, 12 × 2¼ ins., with 24-in. heads. The process of manufacture is described as follows in the Canadian letters patents of 1882:

One of the requirements usually provided for eye-bars to be used for structural purposes is that the head or eye shall have greater strength than the intermediate bar, so that when tested breakage shall be in the bar proper or shaft, and not in or at the head. Great difficulty has been experienced in practice in meeting this requirement and various expedients have been resorted to by rolling, piling and upsetting, to overcome the difficulty without undue increase in expense of manufacture. The purpose of my invention is to provide a cheap and practicable way of securing the requisite strength in the head or eye of such bars without the necessary use of powerful and costly machinery.

In carrying out my invention a wrought-iron bar, A, Fig. 1, of the desired form, length, and area of section, is provided by rolling in the usual way. One or both ends of such bar are given a rounded form, as at a by the use of suitable dies, shears, or other suitable cutting or trimming device. To the curved end a and the side edges near the end of such blank is then welded a correspondingly curved blank B, Fig. 2, the two being applied in welding, as illustrated in Fig. 4. This blank is formed of wrought-iron by rolling or by rolling and hammering by preference in a straight bar, and it is then bent to the curved form shown by means of any suitable bending machine or by compression dies. The end corners, bb, are beveled by shearing or by forging by preference before bending, though it may be done after bending, if desired; and the form of bend is by preference V-shaped, conforming approximately to the end of the bar. The two blanks being placed together, as indicated in Fig. 4, they are placed in any suitable heating furnace—such, for example, as is commonly used for kindred purposes—and are raised to a welding heat. They are then removed, and by the use of any suitable compression or swaging dies the adjacent parts of the two are firmly welded. By this method of reenforcing the ends of a bar to form the head or eye a continuous unbroken fiber is obtained surrounding it in the direction of strain without weakening or distorting the lay of fiber in either end of bar A or in blank B. This I consider an important feature of construction, and it affords the additional advantages that the end of the bar or blank A is prevented from splitting, being banded and bound, as it were, by the blank B and the full, tensile strength of fiber is preserved, especially at or about the base of the head which ordinarily is especially subject to breakage, owing to distortion and displacement of fiber at this point by methods of manufacture heretofore commonly practiced. The pin-hole a' (indicated by dotted lines) is drilled or otherwise made by preference, in the end of blank A, back of the center of the head.

When an equal thickness is desired in both the head and bar shaft the method of manufacture thus far described will afford very desirable results, both on account of strength secured and also on account of cheapness in construction as the steps described in making the bar do not require the aid of powerful and expensive machinery or a high grade of skill in the workmen. For certain classes of work, however, it is desirable to form a raised boss of one or both sides of the head or to make the head thicker than the shaft or bar. To do this I provide plate-blanks C, Fig. 3, of wrought-iron, which are sheared or stamped approximately to the form of the exterior edge of blank B. In applying the blanks C they are placed on one or both faces of the head of the blank Fig. 4, and in case a heavy bar is worked it will be found convenient to secure the plates temporarily by gripping clamps, e, as illustrated in Fig. 5. With light bars, however, the plates may be held by the tongs of the workman while the end of the bar is placed in the heating furnace. When a welding heat has been reached the parts of the head will stick together sufficiently to permit of the requisite handling and in this condition the bar is removed from the furnace, and the parts of the head are firmly united by welding in the usual or any suitable way of such work. The pin-hole a' may then be made as before described, and the head be finished substantially to the form illustrated in Fig. 5, the clamp e of course being removed before welding or worked into the body of metal in welding.

In shaping the blanks C they may be taken with the fiber running with or across that of the blank B, as may be preferred, and in forming the complete head, Fig. 5, the blanks A and B may be first welded and afterward the blank C be welded to the blank, Fig. 4, as above described; or all the blanks may be put together and clamped or otherwise held while heated, and all welded together by one operation. In either case an excellent bar will be secured, which, owing to the direction and uninjured condition of fiber in and about the head, will possess a high degree of strength for the amount of metal employed, and also the method or operation of forming such head can be carried out cheaply and with comparatively small outlay for plant and skill.

Previous to the use of open hearth steel, low Bessemer steel was used by the Keystone Bridge Co. for tension members and in some few bridges all members were made of Bessemer steel. Several bridges were built of Bessemer steel for the Panhandle line, the eye-bars being specified by the late M. J. Becker, M. Am. Soc. C. E., then Chief Engineer, to be made according to Springer's piling method. Table I. shows the results of tests of some of these Bessemer steel eye-bars. As will be noted, the bars were not annealed and they show an increase of strength of about 16% and a great increase in elongation over iron bars. Hundreds of these Bessemer bars were tested at the Keystone works, and no record is had of one breaking in or near the head.

In 1882 open hearth steel was specified by engineers for bridge members and the Keystone Bridge works were equipped for the change. They had in the forge one 5-ton steam hammer with gas furnace attached, one 3½-ton hammer and furnace and two 1,500-lb. hammers and furnaces. There was also a hydraulic upsetting machine that could upset a bar for a 36-in. head, and the first gas annealing furnace in the United States which was designed and built by the writer. A sketch drawing of this furnace is shown by Fig. 6. Fig. 7 is a sketch showing the method of upsetting bars so as to avoid wrinkles in the neck.

The bar B is placed between two flat dies and clamped down by a vertical plunger. Another plunger, A, comes against the end of the bar, as shown. When the bar is heated the free end next to the plunger is covered with clay so that only the portion coming between the opening in the dies is heated. The stroke of the plunger upsets the bar to the shape shown. It is then reheated and formed to final shape by the die, C, and a suitable plunger, D. The bar is then given a wash heat and die forged; then hammered to thickness between flat dies by a helve hammer.

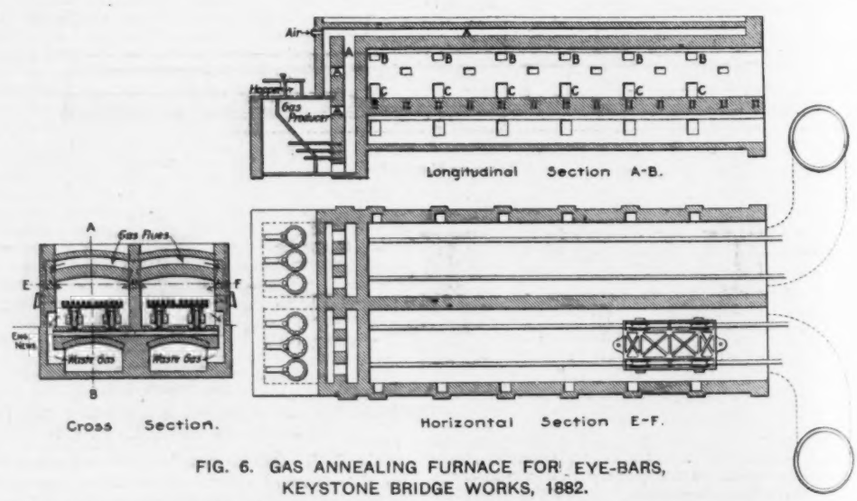


FIG. 6. GAS ANNEALING FURNACE FOR EYE-BARS, KEYSTONE BRIDGE WORKS, 1882.

The annealing furnace shown by Fig. 6 was a twin furnace 54 × 10 × 6 ft. in the clear, built of common brick lined with fire brick. The gas producer is at the rear end. From it the gas passes up through the flues, A, thence into the furnace through the openings, B, and finally out of the furnace through the openings, C, and to the stack. The stacks were about 50 ft. high and were sealed at the top with sand. The drawings show

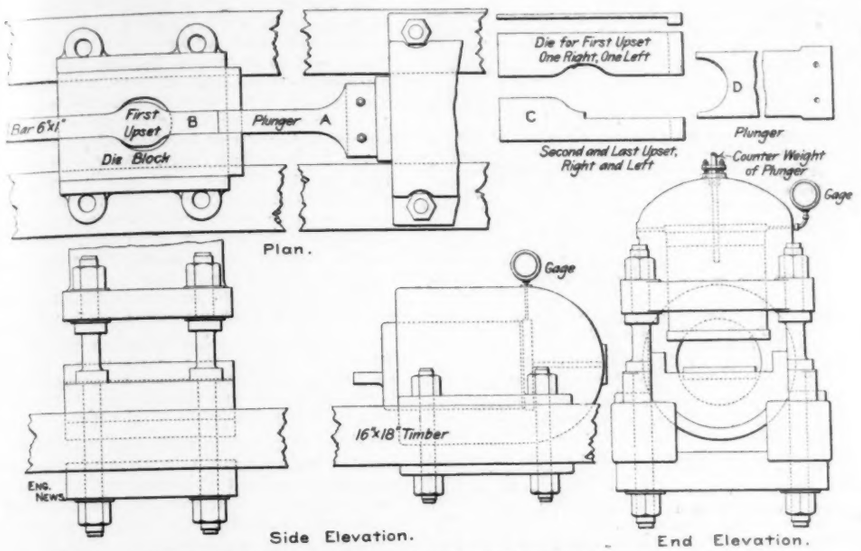


FIG. 7. UPSETTING MACHINE FOR EYE-BARS, KEYSTONE BRIDGE WORKS, 1882.

the arrangement of the rack carriages and tracks. The carriages were operated by endless chains.

The first open hearth steel bridges built in the United States was the Ohio River Bridge at Point Pleasant, W. Va. This had a channel span of 420 ft. and was designed and built by the Keystone Bridge Co. The steel was made by Spang, Chalfont & Co., of Pittsburg, Pa., and rolled by Carnegie Bros. Union Iron Mills of the same city. The bridge was erected in 1883 by Baird Bros.

In an article in the "Iron Age" of July 7, 1904, Mr. Samuel T. Wagner says that little was known about 60,000-lb. steel previous to 1884. By 1884, 60,000-lb. steel had seen its day; open hearth steel had driven it out of the market. The same writer says that the steel for the Point Pleasant Bridge was made by the Cambria Iron Co. It was all made at the mill of Spang & Chalfont. The bridge was designed by Mr. Edwin Thacher, M. Am. Soc. C. E., then engineer of the Keystone works.

Other notable bridges built at these works were the Plattsmouth, Blair, Henderson and Susquehanna River bridges, the latter on the Baltimore & Ohio R. R. Tables II. and III. show the results of tests of eye-bars for the Blair and the Point Pleasant bridges.

THE YELLOW FEVER OUTBREAK AT NEW ORleans had resulted, up to 6 p. m., Aug. 14, in 1,018 cases and 166 deaths, with 210 centers of infection.

SANITATION AT PANAMA is to be given precedence over construction, according to statements made by Chairman Shonts, of the Isthmian Canal Commission, on his return from Panama.

AN ELEVATOR FELL FIVE STORIES in the Chamber of Commerce Building, Buffalo, N. Y., on Saturday, Aug. 12. Five persons were injured in the accident, one perhaps fatally. The cause of the accident is not known at the present writing.

A BUTTING COLLISION on the New York, Chicago & St. Louis Ry., near Vermilion, O., on the morning of Aug. 13, 1905, killed twelve persons and injured about twenty others seriously. An eastbound through passenger train collided with a westbound freight which was late and failed to reach its siding in time.

A LANDSLIDE is reported to have occurred in the valley of the Thompson River, British Columbia, on Sunday afternoon, Aug. 13. A section of the hillside forming the north boundary of the valley slid down upon an Indian village, killing all inhabitants. The occurrence was seen from a train on the Canadian Pacific Ry. which was just then passing along the opposite hillside.

THE FIRST SMOKE NUISANCE PROSECUTIONS at Philadelphia, under an ordinance passed in December, 1904, have been decided in favor of the city. One of the two offenders fined $25 and costs gave notice of an appeal to a higher court.

THE OUTPUT OF CRUSHED LIMESTONE IN NEW York State during 1904, according to a bulletin issued from Albany by the New York State Museum, was 1,471,300 cu. yds. The average price received for the crushed stone used for macadam was 72 cts. per cu. yd. The total production of crushed trap rock was 610,300 cu. yds., nearly half of which was used for road metal.

PERSONALS.

Mr. J. S. O'Flaherty has been appointed Chief Engineer of the Missouri & Louisiana R. R.

Mr. Charles Parsons, of Chicago, is now associated with the Independent Pneumatic Tool Co.

Mr. W. R. Sanborn has been appointed Assistant Engineer of the Indiana, Illinois & Iowa R. R., with headquarters at Kankakee, Ill.

Dr. G. G. Revay, a fuel and gas expert, of 45 Cedar St., New York, sailed Aug. 9 on the "Kaiser Wilhelm II." for Europe on an extensive business trip.

Mr. M. T. Bassett, of the Bullock Electric Co., of Cincinnati, has been appointed Assistant Chief Engineer of the Allis-Chalmers Co., with headquarters in Milwaukee.

Mr. C. E. Douglas has been appointed City Engineer of Meadville, Pa., succeeding Mr. W. A. Jones, who has resigned to accept a position with a railroad construction company.

Mr. E. F. Vincent, heretofore Chief Draftsman of the Missouri Pacific Ry., has been appointed Assistant Engineer at St. Louis, Mo., succeeding Mr. F. B. Scheetz, promoted.

Mr. N. C. Van Natta has been appointed Chief Engineer of the Kanawha & West Virginia R. R., with headquarters at Charleston, W. Va., succeeding Mr. C. P. Payton, resigned.

Mr. Walter E. Dauchey, M. Am. Soc. C. E., Division Engineer of the Culebra Division, Isthmian Canal Commission, at Culebra, Canal Zone, has resigned that position and is now on his way to New York.

Mr. James D. Safford, for the past ten years President of the Chapman Valve Mfg. Co., of Indian Orchard, Mass., has resigned that position, owing to ill health. He is succeeded by Mr. E. A. Carter.

Mr. J. A. Leger, Assistant Engineer of the Public Works Department of New Brunswick, Canada, has been appointed Superintendent Engineer for the Maritime Provinces, with headquarters at Halifax, N. S.

Mr. F. J. Moser, heretofore Engineer of the Chicago & Erie Division of the Erie R. R., at Huntington, Ind., has been appointed Superintendent of that Division, succeeding Mr. J. M. Barrett. Mr. A. Crable succeeds Mr. Moser.

Mr. Felix F. Wiener, Vice-President and Treasurer of Henry Pels & Co., 68 Broad St., New York, is going abroad on a short business trip. During his absence Mr. I. Maddaus, Secretary, will have charge of the office.

Mr. J. R. McColl, who was until the close of the last college term Associate Professor of Steam Engineering at Purdue University, has accepted a position in the Engineering Department of the American Blower Co., at Detroit, Mich.

Mr. F. B. H. Paine, formerly Export Manager of the Westinghouse Electric Co., has been elected Vice-President and Chief Engineer of the Iroquois Construction Co., which is building the electric generating plant of Niagara, Lockport & Ontario Power Co.

Mr. F. H. Koppes has been appointed Assistant Division Engineer of the Monongahela Division of the Baltimore & Ohio R. R., with headquarters at Grafton, W. Va. He succeeds Mr. W. C. Barrett, who has been transferred to the Newark Division, with headquarters at Newark, O.

Mr. Halbert P. Gillette, M. Am. Soc. C. E., M. Am. Inst. Min. E., has resigned his position as a member of the editorial staff of this journal, to take effect about Sept. 1, and has joined with Mr. Geo. H. Gibson in forming the Geo. H. Gibson Co., as noted elsewhere in this column.

Messrs. C. P. Kimball, Architect, of Pittsburg, Pa.; H. Laurent, Architect, of Nashville, Tenn.; Francis J. Norton, Architect, of Jacksonville, Fla., and Archie H Hubbard, Architect, of Champaign, Ill., have been appointed Architectural Draftsmen, Isthmian Canal Commission, for service on the Canal.

Mr. B. H. Hudson, heretofore Engineer of Maintenance of Way of the North Division of the Grand Rapids & Indiana Ry., has been appointed Superintendent of the South Division, to succeed Mr. J. W. Hunter, who has been appointed Superintendent of the North Division, to succeed Mr. W. B. Stimson, the latter having been appointed to the newly created position of Assistant General Manager.

Mr. Geo. H. Gibson, Assoc. Am. Inst. E. E., Jun. M. Am. Soc. M. E., has formed the Geo. H. Gibson Co., Advertising Engineers, and opened an office in the Park Row Building, New York City. Mr. Gibson, some years ago, was on the editorial staff of this journal. Since then he has been connected with the publicity departments of the Westinghouse Companies, B. F. Sturtevant Co. and the International Steam Pump Co., having recently resigned as Manager of Publicity for the last-named company.

Mr. Albert S. Richey, M. Am. Inst. E. E., has been appointed Assistant Professor of Railroad Engineering in the faculty of Worcester Polytechnic Institute. The Polytechnic Institute will establish a new department to give instruction in electric railroad engineering, and it is understood that Mr. Richey is to have charge of this work. Mr. Richey is a graduate of the Electrical Engineering Department of Purdue University and since January, 1905, has been Chief Engineer of the Indiana Union Traction Co.

Messrs. William A. Catteil, M. Am. Soc. C. E., of New York City; William F. Hanrahan, a contractor and builder, of Schenectady, N. Y., and John Magill, a mason-contractor, of Troy, N. Y., have been appointed by Mayor Gaus, of Albany, N. Y., as a special commission to investigate the cause of the collapse of the John G. Myers department store, which occurred Aug. 8 in the last named city. The commission is empowered to make a thorough investigation, fixing the blame for the disaster, if possible. The commission has already started the investigation and will proceed with it as rapidly as the clearing away of the wreckage permits.

Obituary.

A. L. Prichard, of New York, formerly Treasurer of the Chicago & Northwestern R. R. and the Northern Pacific Ry., died recently, aged 86.

Alexander Melville Bell, father of Professor Alexander Graham Bell, died Aug. 7 at the home of the latter in Washington, D. C. He was 86 years old.

C. H. Prescott, a capitalist of Portland, Ore., at one time Manager of the Oregon Railroad & Navigation Co., and Second Vice-President of the Northern Pacific R. R., died Aug. 7, aged 66.

Charles S. Beardsley, founder of the firm of Beardsley, Keeler & Curtis, manufacturers of steel tools, of Auburn, N. Y., died Aug. 12 at his home in that city. He was 90 years old.

Horace C. Silsby, founder of the American Fire Engine Co., died Aug. 12 at his home in Seneca Falls, N. Y., aged 88 years. In 1856 when associated with Birdsall Holley, Mr. Silsby made the first rotary steam fire engine.

Dr. William C. Day, Professor of Chemistry in Swarthmore College since 1888, died Aug. 5 at Swarthmore, Pa., of heart failure. Dr. Day was graduated from John Hopkins University in 1880; was "university scholar" from 1880 to 1881; made fellow in chemistry and physics in

1881 and doctor of philosophy in 1883. He was Professor of Chemistry in St. John's College at Annapolis in 1883 and 1884, and held the same position in the University of Nashville, Tennessee, from 1884 to 1887. Dr. Day was at one time connected with the U. S. Geological Survey as a stone expert, and his report on the stone industry is said to be the most complete ever published. He was several times President of the Chemical Section of Franklin Institute.

ENGINEERING SOCIETIES.

COMING MEETINGS.

NATIONAL IRRIGATION CONGRESS.
Annual convention, Portland, Ore., Aug. 21-4. Secretary, Tom Richardson, Portland, Ore.

LEAGUE OF AMERICAN MUNICIPALITIES.
August 23 to 25. Annual meeting at Toledo, O. Secy., J. McVicar, Des Moines, Ia.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS.
August 23 to 25, 1905. Annual convention at Erie, Pa. Secy., F. P. Foster, Corning, N. Y.

AMERICAN PUBLIC WORKS ASSOCIATION.
Chattanooga meeting postponed until further notice because of yellow fever quarantines. Secy., W. H. Flint, Chattanooga, Tenn.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.
Sept. 5 to 7. Annual meeting at Montreal, Canada. Secy., Geo. W. Tillson, Brooklyn, N. Y.

ROADMASTERS & MAINTENANCE OF WAY ASSOCIATION.
Sept. 12, 14. Annual meeting at Niagara Falls, N. Y. Secy., C. E. Jones, C., B. & Q. Ry., Beardstown, Ill.

NEW ENGLAND WATER-WORKS ASSOCIATION.
Sept. 13 to 16. Annual convention at New York, N. Y. Secy., Willard Kent, Narragansett Pier, R. I.

AMERICAN ELECTROCHEMICAL SOCIETY.
Sept. 18 to 20. Annual meeting at Bethlehem, Pa. Secy., S. S. Sadtler, 39 S. 10th St., Philadelphia, Pa.

AMERICAN PUBLIC HEALTH ASSOCIATION.
Sept. 25 to 29. Annual meeting at Boston, Mass. Secy., Dr. Chas. O. Probst, Columbus, O.

AMERICAN STREET RAILWAY ASSOCIATION.
Sept. 25-30. Annual convention at Philadelphia, Pa. Secy., T. C. Penington, 2020 State St., Chicago, Ill.

ASSOCIATION OF RAILWAY SUPERINTENDENTS OF BRIDGES AND BUILDINGS.
Oct. 17. Annual meeting at Pittsburg, Pa. Secy., R. F. Patterson, Concord, N. H.

MAINTENANCE OF WAY MASTER PAINTERS' ASSOCIATION.
Nov. 13, 14. Annual meeting at Cincinnati, O. Secy., H. J. Schnell, 100 William St., New York, N. Y.

ENGINEERING LITERATURE.

(Concluded from page 186.)

Publications Received.

SIR HENRY BESSEMER, F. R. S.—An Autobiography. With a Concluding Chapter [by his son]. London: "Engineering." Cloth; 9 × 12 ins.; pp. 380; 51 plates and 68 text figures. 16 shillings, net. American price, $5.50.

BULLETINS, U. S. GEOLOGICAL SURVEY.—Charles D. Walcott, Director. Washington, D. C.: Pub. Doc. Paper; 6 × 9 ins.
No. 257: Geology and Paleontology of the Judith River Beds. By T. W. Stanton and J. B. Hatcher. With a Chapter on the Fossil Plants, by F. H. Knowlton. Pp. 174; 19 plates and one text illustration.
No. 263: Methods and Costs of Gravel and Placer Mining in Alaska. By Chester Wells Purington. Pp. 273; 42 plates and 49 text illustrations.

CIVIL ENGINEERING.—A Text-Book for a Short Course By Lieut.-Col. G. J. Fiebeger, M. Am. Soc. C. E., Professor of Engineering, U. S. Military Academy. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 6 × 9¼ ins.; pp. 573; 180 figures in the text. $5, net.

CONCRETE-STEEL.—A Treatise on the Theory and Practice of Reinforced Concrete Construction. By W. Noble Twelvetrees, M. Inst. M. E., Assoc. M. Inst. E. E., Author of "Structural Iron and Steel." London: Whittaker & Co. New York: The Macmillan Co. Cloth; 5 × 7½ ins.; pp. 218; tables and 73 illustrations in the text. $1.90.

CONSTRUCTION OF COUNTRY ROADS.—By Sam Huston. Bulletin No. 2, Highway Department, State of Ohio. Columbus, O.: Pub. Doc. Paper; 6½ × 9½ ins.; pp. 19.

CONTRIBUTION A L'ETUDE DE LA FRAGILITE DANS LES FERS ET LES ACIERS.—Memoires Originaux et Reimpressions. Publication faite avec le concours des six grands compagnies de chemins de fer francais par la Societe l'Encouragement pour l'Industrie Nationale. With an introduction by H. le Chatelier. Paris: The Society (Rue de Rennes, 44). Paper; 9 × 11¼ ins.; pp. 482; numerous plates and many illustrations in the text. 20 fr.; American price, $6.

ELECTRICIANS' HANDY BOOK.—A Modern Work of Reference. A Compendium of Useful Data, Covering the Field of Electrical Engineering, etc., etc. By T. O'Conor Sloane, A. M., E. M., Ph. D., Author of "Arithmetic of Electricity," "Standard Electrical Dictionary," etc. New York: The Norman W. Henley Publishing Co. Leather; 4½ × 6½ ins.; pp. 761; 556 figures in the text. $3.50.

THE ELEMENTS OF GEODETIC ASTRONOMY.—For Civil Engineers. By H. C. Lord, Professor of Astronomy at the Ohio State University and Director of the Emerson McMillin Observatory. Columbus, O.: (The Author). Cloth; 5 × 7¼ ins.; pp. 136; 17 figures in the text. $1.50, net.

ELEMENTS OF THE MATHEMATICAL THEORY OF ELECTRICITY AND MAGNETISM.—By J. J. Thomson, M. A., D. Sc., LL. D., Ph. D., F. R. S., Fellow of Trinity College, Cambridge, Cavendish Professor of Experimental Physics in the University of Cambridge. Third Edition. Cambridge: The University Press. New York: The Macmillan Co. Cloth; 5 × 7½ ins.; pp. 544; 134 figures in the text. $2.60, net.

FLY WHEEL EXPLOSIONS.—By William H. Boehm, M. Am. Soc. M. E. Supplement to the "Monthly Bulletin" of the Fidelity and Casualty Co. of New York, August, 1905. Reprinted, by permission, from the June, 1905, number of "Insurance Engineering." Paper; 6 × 9 ins.; pp. 523 to 542; illustrated.

GEOLOGIC ATLAS OF THE UNITED STATES.—U. S. Geological Survey, Charles D. Walcott, Director. Washington, D. C.: Pub. Doc. Stiff paper; 18 × 22 ins.
No. 123: Elders Ridge Folio. Pennsylvania. Pp. 10; six plates and two text figures.
No. 124: Mount Mitchell Folio. North Carolina-Tennessee. Pp. 9; colored maps.
No. 125: Rural Valley Folio. Pennsylvania. Pp. 11; six plates and five text figures.

HYDRAULIC TABLES.—Showing the Loss of Head Due to the Friction of Water Flowing in Pipes, Aqueducts, Sewers, etc., and the Discharge Over Weirs. By Gardner S. Williams, M. Am. Soc. C. E., Professor of Civil, Sanitary and Hydraulic Engineering, University of Michigan, and Allen Hazen, M. Am. Soc. C. E. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 6 × 9¼ ins.; pp. 75; illustrated. $1.50.

HYDROLOGY OF THE STATE OF NEW YORK.—By George W. Rafter. Bulletin 85, Economic Geology 12, New York State Museum. John M. Clarke, Director. Albany, N. Y.: New York State Education Department. Cloth; 6 × 9 ins.; pp. 902; 99 tables, five folding maps (two in pocket), 45 plates and 74 figures in the text. $1.50.

ILLINOIS BUREAU OF LABOR STATISTICS.—Annual Coal Report, 1904. Also the Sixth Annual Report of the Illinois Free Employment Offices, for the Year Ended Oct. 1, 1904. David Ross, Secretary, Springfield. Springfield, Ill.: Pub. Doc. Cloth; 6 × 8¾ ins.; pp. 425 + 71.

INDUSTRIAL MAP OF THE ERIE RAILROAD SYSTEM. —New York: Erie Railroad Co. Paper; 26½ × 9½ ins.; in form of folder.

MACHINE-SHOP TOOLS AND METHODS.—By W. S. Leonard, Instructor in Machine-Shop Practice and in Practical Machine Design, Michigan Agricultural College. Third Edition, revised and enlarged. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 6 × 9¼ ins.; pp. 554; 689 figures in the text. $4.

THE MANUFACTURE OF COKE IN 1904.—By Edward W. Parker. Extract from Mineral Resources of the United States, Calendar Year 1904; David T. Day, Chief of Division of Mining and Mineral Resources. Washington, D. C.: U. S. Geological Survey. Paper; 6 × 9 ins.; pp. 74; many tables.

THE PRODUCTION OF COAL IN 1904.—By Edward W. Parker. Extract from Mineral Resources, etc. Paper; 6 × 9 ins.; pp. 237.

THE MINING AND QUARRY INDUSTRY OF NEW YORK STATE.—By David H. Newland, B. A., Assistant State Geologist. Bulletin 93, Economic Geology 13, New York State Museum. John M. Clarke, Director. Albany, N. Y.: New York State Education Department. Paper; 6¾ × 8¾ ins.; pp. 909 to 979. 15 cts.

PRACTICAL ALTERNATING CURRENTS AND ALTERNATING CURRENT TESTING.—By Charles F. Smith, Assoc. M. Inst. C. E., A. M. I. E. E., Whit. Schol. Manchester, England: The Scientific Publishing Co. Cloth; 5½ × 8¼ ins.; pp. 437; 204 figures in the text. 6s., net; American price, $2.40.

PROFESSIONAL PAPERS, U. S. GEOLOGICAL SURVEY.—Charles D. Walcott, Director. Washington, D. C.: Pub. Doc. Paper; 9 × 11½ ins.
No. 39: Forest Conditions in the Gila River Forest Reserve, New Mexico. By Theodore F. Rixon. Pp. 89; two plates (one in pocket).

RECUEIL DE TYPES DE PONTS POUR ROUTES.—By Maurice Koechlin, Administrateur-Directeur de la Société de Construction de Levallois-Perret. In Encyclopédie des Travaux Publics, begun by Mr. C. Lechalas. Paris, France: Ch. Béranger. Paper; 6½ × 10 ins.; pp. 306; many tables and 104 figures in the text. With Atlas of folding plates, 10¼ × 12½ ins.

THE STATISTICAL YEAR-BOOK OF CANADA FOR 1904.—Issued by the Department of Agriculture. Ottawa, Ontario: Pub. Doc. Paper; 6 × 9 ins.; pp. 792; diagrams and tables.

STEAM ENGINEERING.—A Treatise on Boilers, Steam, Gas and Oil Engines, and Supplementary Machinery, with Instructions for Carrying out Numerous Simple Experiments Adapted for the Use of Elementary Students in Technical Schools and Science Classes. Second Edition, revised and greatly enlarged. By W. W. F. Pullen, Wh. Sc., M. Inst. M. E., Assoc. M. Inst. C. E., Author of "Experimental Engineering," "Combustion of Fuel," "Indicator Diagrams," etc. Manchester, England: The Scientific Publishing Co. Cloth; 5¾ × 8¼ ins.; pp. 454; 454 figures, mostly in the text. 4s., net; American price, $1.60.

TOOLS FOR ENGINEERS AND WOODWORKERS.—Including Modern Instruments of Measurement. By Joseph Horner, A. M. I. Mech. E., Author of "Pattern Making," "Hoisting Machinery," etc., etc. London: Crosby Lockwood & Son. New York: D. Van Nostrand Co. Cloth; 5¼ × 8¼ ins.; pp. 340; 456 figures in the text. 9s.; American price, $3.50, net.

WATER-SUPPLY AND IRRIGATION PAPERS, U. S. GEOLOGICAL SURVEY.—Charles D. Walcott, Director. Washington, D. C.: Pub. Doc. Paper; 6 × 9 ins.
No. 132: Report of Progress of Stream Measurements for the Calendar Year 1904. Prepared under the direction of F. H. Newell, by T. U. Taylor and John C. Hoyt. Part IX. Western Gulf of Mexico and Rio Grande Drainages. Pp. 133; two plates and one text figure.

WIE MACHE ICH EINE OESTERREICHISCHE PATENT-ANMELDUNG.—A Guide for the Preparation of Patent Papers in Austria. By G. Dimmer and W. von Molo. Vienna: Manzsche Hofbuchandlung, I., Kohlmarkt 20. Paper; 5 × 7½ ins.; pp. 58. 1.2 marks; American price, 50 cts.

PRACTICAL PERSPECTIVE.—A Practical Explanation of the Only Practical Perspective (Isometric). By Frank Richards, Associate Editor "American Machinist," and Fred H. Colvin. New York: The Derry-Collard Co. Flexible cloth; 5½ × 8 ins.; pp. 59; 62 figures in the text. 50 cts.

Isometric drawing might advantageously be used much oftener than it is. Its methods and merits are here described as are also the claims of the publisher for a specially ruled isometric drawing paper.

THE COMMERCIAL MANAGEMENT OF ENGINEERING WORKS.—By Francis G. Burton, A. S. A. A., Incorporated Accountant, Author of "Engineering Estimates and Cost Accounts," "Engineers' and Shipbuilders' Accounts," "Engineering Valuations," etc. Second Edition, revised and greatly enlarged. Manchester, England: The Scientific Publishing Co. Cloth; 5¾ × 8¾; pp. 432. 12s. 6d. net; American price, $5.

The title of this book is somewhat misleading to an American in that the book is largely a treatise on accounting and cost keeping in manufactories. While several American authors have written books on the same subject, it does not follow that this volume will prove of minor value to an American. The author is not the promoter of any pet theory of cost-keeping and profit-sharing, and is evidently conversant with American literature on the subject. Perhaps his occasional tendency to belittle American ideas is not without its value as an aid to clear thinking and careful weighing of all the claims made by the exponents of different methods of paying workmen and of recording the daily work done.

Of Mr. Frederick W. Taylor's "differential piece-work rates" for paying workmen, the author says:

> This method of paying men is not only opposed to all trade union aspirations, but it appears to be utterly lacking in that "equal justice," without the exercise of which no employer can, for any length of time, obtain the best and most zealous service from his employees.

The statement is then made that in England the premium system seems to have found more favor than the differential piece-work method for stimulating workmen, and a specific example is given to illustrate the point.

The book contains many forms illustrating the methods of recording the cost of work, order sheets, time books, cost estimate blanks, receipts, etc. Occasionally one of these forms may give a hint of value even to a manager who is familiar with American literature on the subject.

The general scheme of the book can be further stated by saying that the several officers of private corporations, other than the president, are discussed, including "the draftsman," after which the purchase, inspection and receipt of materials are considered. Accounts, including depreciation and interest charges, are given a number of chapters. Reports to the board of directors and customs and shipping regulations are also treated.

GEOLOGY OF WESTERN ORE DEPOSITS.—By Arthur Lakes, Late Professor of Geology at the Colorado School of Mines. Author of "Prospecting for Gold and Silver in North America," "Geology of Colorado Coal Fields," etc., etc. New Edition, entirely rewritten and enlarged. Denver, Colo.: The Kendrick Book & Stationery Co. Cloth; 6 × 8¼ ins.; pp. 438; many illustrations. $2.50, net.

This is the second edition of a work originally entitled "Geology of Colorado and Western Ore Deposits," published ten years ago. The book has been enlarged and brought up to date.

The first half of the volume relates to general features of mining geology, and is written in a manner so lucid as to be within the understanding of any man of common intelligence. Moreover it is profusely illustrated with the pen sketches for which the author has become noted. Throughout the book these sketches serve not only to elucidate the text but also to give a personal character to the work that makes it seem more like a series of private talks than a number of printed chapters on mining geology.

The author illustrates theories and general principles by many special examples, drawn mainly from mining camps in Colorado. Further illustrations are taken from some of the noted mining districts in other parts of the West. The larger part of the text relates to ore bodies in place, but one good chapter of 40 pages gives an excellent description of placer deposits.

It would seem that this book might well be used as a text book in mining colleges. The author was formerly professor of geology at The Colorado State School of Mines, and is a well known authority on geology, and in addition to both these qualifications he possesses an unusual knack in arousing the interest and holding the attention of the reader.

ENGINEERING LITERATURE

Supplement to ENGINEERING NEWS. New York, August 17, 1905.

CONTENTS.

EDITORIAL:
The Indiscriminate Use of the Word "Efficiency."—The Engineer's Need of a Reading Knowledge of French and German.—An American Section for the Municipal Library, Frankfort, Germany.. 179

REVIEWS:
The Fan. Reviewed by D. W. Taylor..... 179
How to Prepare for a Civil Service Examination... 181
Geological Survey Bulletins 181
Four German Books. Reviewed by Storm Bull.... 181
Coke and Coke Ovens..... 182
Hydraulic Machines (French)..... 182
Hydraulic Power Engineering..... 182
French Testing Laboratory Bulletins 183
Nickel steel 183
The Berlin-Zossen Electric Railway Test..... 183
A German Handbook for Structural Design..... 184
Additional German Literature 185
Gold Dredging and Placer Mining..... 186
Sanitation of a Country House..... 186
German Technical Words and Phrases..... 186
Publications Received 178

A very proper protest is made in this issue by Mr. D. W. Taylor in the course of a review printed on another page, against the indiscriminating misuse of the word "efficiency" which is prevalent in the discussion of certain types of machine. This protest might be supported at length by illustration and argument, were it at all needful; but we think that nearly every reader of technical literature can readily call up instances of the misuse in question, and will appreciate the merit of the protest. An uncommon phase of the matter, however, can be mentioned here as a supplement to the more ordinary instances: the application of the term "efficiency" to machines which perform qualitative work and lack the character of energy-converter. A writer on electrochemical subjects, in discussing electric furnaces, attempted to characterize the merit of various furnaces by computing an efficiency for each. In these machines energy is supplied in the form of electricity; in some of them a definite amount of energy is absorbed in specific chemical reactions, but with this exception they are mere heating appliances comparable to a kitchen stove. In one instance, where a furnace had the function merely of aggregating a pulverized material into a coarser aggregate, by partial fusion, this writer yet managed to compute an "efficiency" for the furnace. The procedure is directly comparable, it would seem, to computing the "efficiency" of a lathe, or of a baker's oven.

The term "efficiency" is not the only one thus abused. "Characteristic" is almost equally mishandled. The writings on electric machines or apparatus are full of "characteristics," which mean the most various things under the sun. In general, the term means nothing more than the ratio of two interdependent quantities, or rather the representation of this ratio over a certain range of one of the quantities. Of course there can be no objection to using the word as a mere substitute for "ratio," except that it is longer and more awkward. But the objection lies against the use of the word as a specific term; that is to say, specific with one meaning on one page, and with another meaning on another page. The writers who indulge in this abuse do not trouble to write "brush voltage characteristic," "speed characteristic," or otherwise to suggest the momentary meaning of the term. Their attitude is: "There's the word; find out from the text or the diagram what I mean by it at the present moment." At one time, years ago, it may have been safe to interpret "characteristic" as "voltage-current curve." To-day, with the greater diversity of types of electrical machines, and the greater number of their properties which is studied, a writer has little reason to use the term in a specific sense.

A reading knowledge of French and German should be a part of the equipment of every ambitious young engineer. To speak for the moment of German alone, the many books in that language reviewed in this Supplement from time to time give a hint as to what is being missed by engineers who do not read German. In this issue of the Supplement alone ten books in the German language are noticed, and most of them have come to hand since July 1. Mere numbers, of course, have little significance in this case, but we direct attention to the surprisingly large proportion of these books which the reviewers commend or even praise. A careful survey of the notices and reviews of German books in the columns of this Supplement cannot fail to impress one with the feeling that the writing of engineering textbooks is on a very much higher plane in Germany than in America or England. Indeed, it would almost seem that the Germans might be the purveyors of technical literature to the world, were it not for those limitations of local development which restrict the value of many books to the country of their origin. These limitations being duly allowed for, the German technical literature remains of such value to American engineers that a direct loss is incurred by those who neglect it.

A similar recommendation to study the foreign literature might be made with reference to French works, which, while as a class inferior in both number and excellence to the German productions, are yet in many respects invaluable.

A clear and forceful statement, by a non-engineer, of the proposition that a knowledge of French and German is an essential part of an engineer's equipment, may be of interest here. Mr. Charles Francis Adams, in an address to university alumni in 1883, said:

> I believe from your own personal experience you will bear me out when I say that, with a single exception, there is no modern scientific study which can be thoroughly pursued in any *one* living language, even with the assistance of all the dead languages that were ever spoken. . . . With the exception of the law I think I might safely challenge any one of you to name a single modern calling, either learned or scientific, in which a worker who is unable to read and write and speak at least German and French does not stand at a great and always recurring disadvantage. He is without the essential tools of his trade. The modern languages are the avenues to modern life and living thought.

That these words are twenty-two years old does not divest them of truth and vigor. Conditions, it is true, have become slightly changed: our later work here in America has pursued a more independent and self-satisfying line of development in many fields than did our earlier work; but while we have made advances all along the line and at points have proceeded by leaps and bounds, yet we still have very much to learn from the thinkers and workers of other countries. Some of the best German and French literature is translated into English, but for the most part such translated information is fragmentary in character and tardy in the date of its appearance. To keep thoroughly abreast of engineering progress one must read both German and French; to read but one of these languages is little enough for any progressive engineer.

A commendable attempt to form a large American section in the city library of Frankfort-on-the-Main, Germany, is being made by a committee of which Doctor Adickes, Mayor of Frankfort, is chairman, and Mr. Richard Guenther, U. S. Consul-General, is a member. The following are excerpts from a letter on the subject signed by Mayor Adickes as chairman of the committee:

> Being convinced that the dissemination of more perfect knowledge concerning the political, social, economic and intellectual life of the United States of America is urgently desired in Germany, and also that no German city is better fitted as a center for such purpose than Frankfort-on-the-Main, situated as it is in the heart of Germany, a committee has been formed to accomplish this end.
>
> The committee is of the opinion that the desired end can be best accomplished by adding a section for American literature to the Municipal Library of Frankfort-on-the-Main, an institution which, with more than 300,000 volumes, ranks among the most important libraries of Germany, its main strength being in the departments of history, law and political science.
>
> This American section will be especially devoted to the philosophical, historical, judicial, political, industrial, commercial and sociological literature of the United States. Such an American section of the Municipal Library of Frankfort would be extensively used by the widest circles, as this library is open to every one, free of charge, and its large reading room is always available to the public.
>
> The committee proposes to extend its work in two directions in order to accomplish its object:
>
> (1) It intends to collect contributions to enable the Municipal Library to purchase such American literature as can be procured only from publishers and dealers. A considerable sum has already been secured in voluntary contributions from public-spirited citizens.
>
> (2) The committee has furthermore decided to request the Government of the United States, as well as the governments of the several States of the Union and of the larger municipalities, also the most prominent universities and educational institutions, the scientific associations of the United States, the chambers of commerce, etc., to supply this American section with their publications, past, present and future.
>
> In this way the committee expects that the American section of the Frankfort Municipal Library will be enabled to collect much valuable American literature, treating of all the problems of public life in America, its constitutional and economic history, administration, finance, transportation, commerce, industries, laws, customs, duties, social science, etc., to the widest extent, thereby making it possible for the scientists and politicians not only of Frankfort, but of all of Germany, to acquire a thorough knowledge of American conditions.
>
> In the hope that you will gladly assist an effort which will form an important link in the amicable relations between the United States and Germany, we respectfully request you to aid us by transmitting to the Municipal Library of Frankfort-on-the-Main, Schoene Aussicht No. 2, all such publications as are at your disposal, and to continue to send them regularly as they hereafter appear. The Municipal Library will, if desired, gladly pay the expenses for packing and for postage or freight.
>
> Should you desire more detailed information, Mr. James Speyer, of the banking firm of Speyer & Co., of [24 Pine St.] New York, will gladly furnish it.

We trust that many of our American municipalities, engineering and other societies and perhaps a goodly number of private individuals will send publications to the library, at the address named. Municipal and other public officials in particular can aid in building up at Frankfort a library of American literature which will be a credit and a help to both Germany and America.

REVIEWS.

Innes on the Fan.

Reviewed by D. W. Taylor.*

THE FAN.—Including the Theory and Practice of Centrifugal and Axial Fans. By Charles H. Innes, M. A. (Cantab), Lecturer on Engineering at Rutherford College, Newcastle-upon-Tyne, Author of "Centrifugal Pumps, Turbines, and Water Motors," and "Problems in Machine Designs." Manchester, England: The Technical Publishing Co., Ltd. (New York: D. Van Nostrand Co. Cloth; 5 × 7½ ins.; pp. 252; many tables; 142 figures, mostly in the text. 4s. net; American price, $2.

This work consists essentially of three parts: (1) The development of a number of mathematical formulae by which it is attempted to represent completely the action of fans; (2) descriptions of experiments with fans condensed by the author from original papers and articles in English and French; (3) application of the author's formulae to experimental results with a view to demonstrating the accuracy of the former.

While it is not so stated by the author, it would seem from the text that he usually had in mind large fans, such as are used for mine ventilation rather than the smaller, quick-running fans used for ventilating buildings and ships.

Chapters 1 to 6, inclusive (58 pages), are devoted to the development of theoretical equations on the operation of fans. Chapters 7 to 11, inclusive (110 pages), are devoted to descriptions of various experiments condensed from the transactions of technical societies, etc., including experiments with a centrifugal pump made by the author, and with another centrifugal pump made by the Hon. R. C. Parson. Chapters 12 and 13 (14 pages) are devoted to a comparison between

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the author's theory and experiments. The remaining 50 pages of the book are devoted to a brief description of high-pressure fans, summarized from a paper by Professor Rateau, to the development of an admittedly incomplete theory of propeller fans, to descriptions of published experiments upon propeller fans, and finally to a brief description of various types of propeller fans, including particularly the Rateau screw fan.

The author begins with the sound premise that centrifugal fans for air are usually centrifugal *pumps*, the compression of the air being seldom large enough to be taken account of in any theory. Upon this foundation, starting with well-known turbine formulae, the author has erected a most elaborate structure of equations which can be made no use of in practice, for the reason that they involve a number of coefficients and constants which vary radically from fan to fan, and hence cannot be determined until the fan is made and tested. In fact, for practical application, the work is nearly always inconclusive and indeterminate. An illustration of this occurs almost at the beginning. On pages 4 and 5 the author discusses briefly the loss of head by surface friction in a passage, developing the well-known formula for the same, which he puts for a circular pipe into the form,

$$h_1 = \varphi \frac{4\,l}{d} \frac{v^2}{2g},$$

where h_1 is the loss of head in a circular pipe of length l and diameter d, due to the air velocity of v feet per second, g is the acceleration due to gravity and φ is the coefficient of friction. With reference to the actual value of φ the author says "Prof. Unwin, in the 'Development and Transmission of Power,' gives

$$\varphi = .0027\ (1 + \frac{3}{10\,d}),$$

where d is diameter of pipe in feet. M. Leiong gives $\varphi = .006$." Here we have two values of the coefficient of friction, one of which is double the other for pipes of 3 ft. or more in diameter. The author expresses no opinion on the subject and gives no other information on this important question, although on page 131 he uses the value .004 for the coefficient of friction, which is something like the mean between the two values. As a matter of fact, careful experiments in this country have shown that the value of φ for smooth circular pipes in the best condition and alinement is a little over .005. One of the largest fan manufacturers in the country publishes tables for the flow of air through pipes, which are generally accepted as reliable for general purposes. These are based upon a coefficient of friction corresponding to the value for φ of .0064.

The author follows what appears to be a practice common abroad of calling almost every ratio connected with the operation of the fan an "efficiency." He uses manometric efficiency, mechanical efficiency, air efficiency, volumetric efficiency and dynamic efficiency. He is somewhat chary of definitions in terms of these various efficiencies, but from examination of the equations and such definitions as he gives it is gathered that his manometric efficiency is the ratio between the pressure developed by the fan at its outlet and the total theoretical pressure which would be developed if the velocity of the air as it leaves the fan tips were converted without loss into pressure head and added to the actual pressure head. There appears to be even less reason for calling this ratio an "efficiency" than there would be, for instance, in calling the ratio between the mean effective pressure in an engine and the boiler pressure an "efficiency." The term "mechanical efficiency," as used by the author, expresses the ratio between the work done in forcing the air from the fan against pressure and the work done upon the fan wheel. This does not take account of the energy carried away by the air due to velocity, which it must have if it leaves the fan at all. Taking account of this, the efficiency, according to the author, becomes the "dynamic efficiency," which he considers a very useless and objectionable efficiency. The efficiency which the author appears to prefer is the "air efficiency," or the ratio between the work done per unit weight in forcing the air against pressure and the theoretical work done by the fan wheel upon the air derived from the well-known turbine formula,

$$\frac{c_1\,w_1}{g},$$

where c_1 is rotary velocity of the blade tips and w_1 is the velocity of whirl of the air as it leaves the blade tips. This is a theoretical quantity which it would be difficult enough to reasonably approximate in any case, but the author increases the difficulty by assuming that the air leaves the wheel at an angle with the vane, which increases with the discharge, and also depends upon the number of blades. Apparently the exact angle applicable to any particular case is to be determined by judgment. For the volumetric efficiency, so-called, the author gives two expressions, one of them,

$$\delta = \frac{Q}{c_1\,r_1^2},$$

and the other,

$$\delta_1 = \frac{Q}{c_1\,r_1\,b_1},$$

where Q is the discharge per second, c_1 the velocity of the blade tips, r_1 the radius of the blade tips, and b_1 the breadth of the blade tips. The author considers δ_1 the more correct value for the volumetric efficiency. It is seen from the equation that this "more correct value" is $2\,\pi$ times the ratio between the outward velocity of flow through the blade tips and circumferential velocity of the blade tips. There appears to be no justification for calling this quantity an efficiency. As a matter of fact, none of the "efficiencies" which the author uses appear to be real efficiencies in the ordinary, common-sense, engineering meaning of the word, except his much-despised "dynamic efficiency." It would seem that the real efficiency of a fan should obviously be the ratio between the input of work and the output of work, the former including all the energy devoted to turning the fan, the latter including the work done against pressure by the air which leaves the fan and the kinetic energy in the air which it carries away from the fan. For mine exhausters exerting a strong suction and discharging into the atmosphere there is a natural temptation to regard the kinetic energy in the air at discharge as wasted, but for fans supplying air it is just as necessary to give the air velocity as to give it pressure.

The author develops exceedingly complicated equations for his manometric and mechanical efficiencies largely in terms of ϕ, the assumed but unknown angle at which the air leaves the fan tips, for a number of types of fans. He supposes that the air may be discharged directly from the fan tips into the atmosphere, or that it may pass from the fan tips to a diffuser, or a casing concentric with the fan which is parallel-sided, or nearly so. From the diffuser the air may pass directly to the atmosphere or to the ordinary spiral volute. Also it may pass directly from the blade tips to a volute without a diffuser. Finally, from the volute the air may be discharged to the atmosphere directly or through a gently expanding pipe, which the author calls throughout a chimney. Equations are derived for various combinations of the above elements, but for practical application these equations are of little value.

The author in Chapters 12 and 13 devotes some fifteen pages to a comparison between his formulae and results of experiments. One of his fundamental formulae—that for manometric efficiency—is

$$\frac{1}{M} + \frac{P\,O}{\sqrt{M}} - R\,O^2 - S = 0$$

where M is manometric efficiency, O is "equivalent orifice," another name for an old friend known in this country as "blast area" or "hold-up area" and P, R and S are coefficients depending upon the fan. The author gives values to these coefficients which make the calculated values of M agree very closely with the experimental values for four fans experimented with by Donkin. These values are below:

Donkin's Fan.	P.	R.	S
VIII.	—.136	14.18	.039
VI.	.192	5.85	.0206
X.	2.43	13.56	.0735
XI.	10.05	126.4	.031

Any one about to design a fan would evidently find it difficult to determine in advance suitable values of P, R and S in the author's equation. The most that can be said for the above results is that they exemplify the well-known fact that given a sufficient number of variable coefficients an experimental curve can be expressed by an empirical equation.

The author upon applying his formula for "air efficiency" to experimental results is able to find concordance with but two fans. He ascribes failure in other cases to errors of the experiments, difficulty of determining real discharge angles, etc.

The author's discharge angle theory, already mentioned, is somewhat remarkable. It is, in brief, that the air is discharged at a greater angle than that of the vanes, that is, at an angle with the vanes. If the air in the runner is moving at an angle with the vanes, as the author supposes, it must be flowing through them or be compressed at the back of the vanes and leave a partial vacuum in front. If the air just as it is discharged suddenly changes its direction of flow to reach the direction the author supposes, it must change direction by a sudden leap *ahead*.

Doubtless the author's equations agree better with observed facts upon the assumption that the air is not discharged at the vane angles, but that fact will not warrant impossible conclusions as to the actual behavior of the air.

The author's treatment of the Pitot tube is another instance of his irritatingly inconclusive methods. On page 71 he gives the ancient Pitot tube formula,

$$H = m \frac{v^2}{g},$$

where H is the head in feet, v is the velocity in feet per second, g is acceleration due to gravity and

m is a coefficient smaller than unity, depending probably upon the section of the orifice and of that of the conduit in which it is situated. When the orifice is small compared with the conduit, experiment shows that m = ½ very nearly.

On page 94 we find another Pitot tube formula obtained from the report of the Prussian Mining Commission of 1884, which is

Velocity of air in meters per second = $4.265\sqrt{\frac{\text{pressure in millimeters of water}}{\text{density of air}}}$

when the temperature of the air is zero Centigrade. If it is altered for the warmer temperatures of air it becomes very nearly the same as

$$v = 4\sqrt{h},$$

the formula used by Mr. Bryan Donkin.

Referring to page 91, where Mr. Donkin's formulae are given, we find that V is velocity of air in meters per second, and h pressure in millimeters of water. Presumably the "density of air" in the Prussian Commission's formula is referred to density at zero Centigrade as unity. Upon this assumption the Prussian Commission's formula for velocity at temperature of zero Centigrade becomes

$$v = \sqrt{77\,H},$$

where H is head of air in feet and v velocity in feet per second. Reducing Mr. Donkin's formula in the same way upon the assumption that it applies to average air having a weight of .075 lbs. per cu. ft. at 62° F., as assumed by the author on page 11, we have

$$v = \sqrt{63.06\,H}.$$

The author gives us these three formulae to be used with the Pitot tube, but leaves the question

of the proper coefficient indeterminate. It is true that he says that when the Pitot orifice is small experiment shows that $m = \frac{1}{2}$ very nearly, corresponding to the correct formula,

$$v = \sqrt{2 g H},$$

but subsequently he gives other formulae, which, although somewhat indefinite, differ from each other and from the correct formula. One is left to wonder what formula the author would adopt if he were making experiments by Pitot tube methods. As a matter of fact, experiments with water and air in this country have shown conclusively that the formula

$$v = \sqrt{2 g H}.$$

is practically exact up to any size of tube which one would reasonably use.

The troubles often encountered in Pitot tube experiments have been due to the fact that to measure velocity in air or water moving under pressure it has been necessary to determine by side openings the pressure in the moving fluid, and in many cases side openings have been used which, because of unsuitable shape or location, failed to transmit the correct pressure. For the impact end of the Pitot tube, however, there is no such difficulty and the total head is correctly given by it over a wide range of shape and size.

Coming to minor points it should be pointed out that the book is singularly lacking in clean-cut definitions and the verbiage could be made clearer in places.

In Fig. 6, perhaps the most important figure in the book, the very important angle ϕ is not indicated, although an arrow across the angle appears. In the third equation on page 168 c_1^2 should have been c_1^3.

On page 128 there is a curious blunder in describing a fan at Seghill Colliery. This fan is stated to have an external diameter of 35 ft. 1 in., a shaft 12 ins. in diameter with "the inlet 12½ ins. on one side." In the index under "Seghill Colliery, Experiments on a Fan at," we are referred to page 179, where the author begins a discussion of the experiments with this fan, but there is no reference to pages 128-9, where we have a description of the fan itself and data of the experiments.

This book has the commendable object, according to the author, of service to those who have to design or wish to understand the working of fans. It will be of little use to either class. The complicated general equations deduced by the author have no value for practical application without definite and reliable values of the coefficients contained in them. These the author has not supplied. The descriptions of experiments with fans and pumps constitute the most valuable part of the book, but in condensed form they are less valuable than the original memoirs and papers—all of which of value are available in the transactions of various technical societies.

HOW TO PREPARE FOR A CIVIL SERVICE EXAMINATION.—With Recent Questions and Answers. By Francis E. Leup. New York: Hinds, Noble & Eldredge. Cloth; 5¼ × 7½ ins.; pp. 585. $2.

Although last revised in 1899, and although the revision then given was chiefly in the form of an appendix, this book still has a large measure of serviceability. It would be well, however, if it could now have a thorough revision, with all the appendix matter and all changes since the appendix was prepared inserted in their proper places. After some explanatory statements, the book proceeds to give the qualifications for and samples of the questions asked candidates in a large number of classes of the United States civil service. The localities at which various examinations are conducted are given and also the salaries paid. A ten-week's course of study for those wishing to undertake a general preparation for civil service examinations is quite fully given.

IRRIGATION INVESTIGATIONS ON THE NORTH PLATTE RIVER IN 1904.—Bulletin 66, Wyoming Experiment Station. By B. P. Fleming, Irrigation Engineer, Laramie, Wyo.: As above. Paper; 6 × 9 ins.; pp. 24.

These studies relate to the use of water on a number of irrigated farms.

Geological Survey Bulletins.

BULLETINS, U. S. GEOLOGICAL SURVEY.—Charles D. Walcott, Director. Washington, D. C. Pub. Doc. Paper; 6 × 9 ins.

No. 238: Economic Geology of the Iola Quadrangle, Kansas. By George I. Adams, Erasmus Haworth and W. R. Crane. Pp. 83; 11 plates, 13 text illustrations and folding tables.

No. 243: Cement Materials and Industry of the United States. By Edwin C. Eckel. Pp. 395; 15 plates (maps) and one text diagram.

No. 247: The Fairhaven Gold Placers, Seward Peninsula, Alaska. By Fred H. Moffett. Pp. 85; 14 plates and 2 text figures.

No. 250: The Petroleum Fields of the Pacific Coast of Alaska, with an Account of the Bering River Coal Deposits. By George C. Martin. Pp. 64; seven plates and three text illustrations.

No. 255: The Fluorspar Deposits of Southern Illinois. By H. Foster Bain. Pp. 75; six plates and one text illustration.

No. 258: The Origin of Certain Place Names in the United States (Second Edition). By Henry Gannett. Pp. 334.

No. 262: Contributions to Mineralogy from the United States Geological Survey. By F. W. Clarke, W. F. Hillebrand, F. L. Ransome, S. L. Penfield, Waldemar Lindgren, George Steiger, and W. T. Schaller. Pp. 147; 12 figures in the text.

No. 260: Contributions to Economic Geology, 1904. By S. H. Emmons and C. W. Hayes, Geologists in Charge. Pp. 620; four plates, and 25 text figures.

No. 264: Record of Deep Well Drilling for 1904. By M. L. Fuller, E. F. Lines, and A. C. Veatch. Pp. 106.

The bulletin on Cement (No. 243) opens with a brief and general review of the "Materials and Manufacture of Portland Cement," designed to aid such as are not familiar with those subjects in understanding the main part of the bulletin. The bulk of the volume describes, State by State, the Portland cement resources of the country. Then follow sections on the natural cement resources of the United States and one on "Materials and Manufacture of Puzzolan Cements." It appears that the author "visited every district in which cement was being produced and has examined nearly every cement plant in operation." Information regarding undeveloped resources is also included.

One must be sadly lacking in appreciation of historical and antiquarian research who fails to be interested in Mr. Gannett's Place Names. It consists of a list of over 8,000 names of states, counties, towns, rivers and mountains in the United States, with a brief note attached as to the origin of the name and its meaning if taken from some foreign language. It is well that this work has been done at this time, for the lapse of years renders it more difficult by far to trace the origin of these names, particularly those in that vast region between the Mississippi and the Pacific, in which the great bulk of the geographic names now existing are creations of the last half century.

It is an interesting record of our natural history that is contained in these geographic names. We have the names in New England and the Middle States and to some extent in the states further south along the Atlantic seaboard, for the most part perpetuating the names of home places left behind in the mother country or honoring the famous men of that day. Mixed with them, particularly in those parts of the country a little back from the sea coast, such as New Hampshire, we have a great number of names derived from the Indians. New York names record the Dutch origin of the settlers, and in many Pennsylvania names can be traced the fact that a multitude of religious sects sought shelter there under the tolerant rule of William Penn. In the Northwest and in Louisiana, the record of the French settlement is everywhere impressed, and in the Southwest the former prevalence of the Spanish tongue is likewise recorded.

Last but not least, let us set down here that the future antiquarian who studies the history of the Western United States will find abundant evidence in the local geographic names that the locomotive was the pioneer for the settlers, and that the opportunity to immortalize one's own name by christening stations, town sites and even counties, rivers and mountains, was diligently improved by Presidents, General Managers, Division Superintendents and by locating and constructing engineers of all grades. Indeed, we find recorded in this book that one Chief Engineer, having (we presume) perpetuated his own name to his satisfaction, caused a county to be given the family name of his wife.

Bulletin 260 gives data on the occurrence, distribution and production of gold, silver, tin, molybdenum, uranium, vanadium, copper, lead, zinc, iron, manganese, coal, petroleum, gas, asphalt, building stone, clays, salt, gypsum, sulphur, phosphates, mica, graphite and abrasive materials. The Portland cement resources of America are set forth in 53 pages of the Bulletin.

In its present form, the work reported in Bulletin 264 was begun in the latter portion of 1904. A yearly report may be expected hereafter, dealing with current records. Means are employed to get track of all deep wells sunk, regardless of their object, and then to obtain records, with samples of materials penetrated. Obviously the work will be of value to geologists, hydrologists, many engineers and contractors, oil producers and others. An attempt is being made to cover the whole country, and the information secured, within reasonable limits, is open to any one at any time.

Four German Books.

Reviewed by Storm Bull.*

DAS ENTWERFEN UND BERECHNEN DER VERBRENNUNGSMOTOREN.—Handbuch für Konstrukteure und Erbauer von Gas und Oelkraftmaschinen. By Hugo Güldner. Second edition, greatly enlarged. Berlin: Julius Springer. Cloth; 8 × 10¾ ins.; pp. 626; 30 plates, and 800 figures in the text. 24 marks; American price, $9.60.

ENTWERFEN UND BERECHNEN DER DAMPFMASCHINEN.—A Text-book for Students of Design. By Heinrich Dubbel. Berlin, Germany: Julius Springer. Cloth; 6 × 9½ ins.; pp. 437; folding and other tables, and 388 figures in the text. 10 marks; American price, $4.

NEUERE TURBINENANLAGEN.—Compiled by Wilhelm Wagenbach, Engineer at the Royal Technical College at Berlin. With the use of "Der Turbinenbau auf der Weltausstellung in Paris 1900," by Professor E. Reichel. Berlin: Julius Springer. Cloth; 8 × 11 ins.; pp. 127; 54 plates, and 48 figures in the text. 15 marks; American price, $6.

ZWANGLAEUFIGE REGELUNG DER VERBRENNUNG BEI VERBRENNUNGSMASCHINEN.—By Carl Weidmann, Assistant in the Technical High-School at Aachen. Berlin: Julius Springer. Paper; 5⅝ × 8¼ ins.; pp. 138; five plates, and 35 figures in the text. 4 marks; American price, $1.60.

These four works, all published by a single well-known Berlin house, are individually and collectively a valuable addition to the literature of mechanical engineering. They are worthy companions to such standard books of recent years as Leist's "Valve Gears," Stodola's "Steam Turbines," Tolle's "Steam Engine Governors," Weiss' "Condensation," and Güldner's "Gas Engines," which, it is proper to remark, were brought out by the same publisher. The last-named book, in fact, is represented in the list of four at present under review, a revised and enlarged second edition having been just issued.

At the time of the original publication of Güldner's "Gas Engines," the work was pronounced in these pages to be the best book existing on its subject. In its present enlarged and improved form it merits that characterization only the more strongly. In order to make the book more useful for the practising engineer, the author has shortened some of the parts of more historical than practical interest, thus giving more room to discuss modern constructions and designs. Of the latter, this second edition contains a wealth that is almost marvelous. The theoretical sections have also been strengthened in various ways. In fact, the revised book can hardly be criticized, but merits praise in all its parts. It is almost unnecessary to state that the reviewer still has the fervent hope, already expressed in the review of the first edition, that somebody will be found who will undertake the very large task of translating the book into English.

Dubbel's book on the steam engine is, according to the sub-title, written with the purpose of helping engineers and students in computing and designing steam engines. The author has succeeded remarkably well in carrying out his purpose. The book is divided into 15 chapters, of which the most important ones are: Theory of the mechanics of gases and vapors; The behavior of steam in the engine; Valve gears; Condensation; The compound engine; Influence of the reciprocating parts and the flywheel; Governing; Steam turbines; Testing of steam boilers and engines. It will be apparent from this that the book covers a wide field, and as it is not very voluminous—437 pages—great concentration and

*Professor of Mechanical Engineering, University of Wisconsin, Madison, Wis.

concise treatment was required to cover the field well. It is rare to find so short and yet so clear a presentation of a subject as complex as this one. The qualities of clearness and conciseness are particularly noteworthy in the presentation of the fundamental principles of thermodynamics and their application to the steam engine, contained in the first two chapters. The discussion of governing is also very satisfactory, the shaft governor receiving as much attention as American engineers could desire. However, as is stated in the preface, the book is written for a German public, and in consequence some special features of the steam engine, as valve gears for poppet-valve engines, receive a good deal more attention than would perhaps be desirable for the American profession. But this again may be explained by the fact that the superheating of steam has been utilized much more, and to a much higher degree, in Germany than elsewhere.

The author has made good use of the recent works of Stodola and Leist, and in general it may be said that he is evidently very familiar with both modern design and the modern literature of the subject.

On another occasion the reviewer has advanced the opinion that there is no satisfactory book in the English language on the design of the steam engine. After reading Dubbel's work, this opinion is only confirmed. The reviewer believes that a translation of the book, with some modifications and additions to make it more directly useful to the American engineering profession, would come much nearer to the requirements than any book now available in the language.

A reference book for the practicing engineer is presented in Wagenbach's "Turbine Power Plants." It contains a collection of accurate and concise descriptions, in text and illustration, of nearly all the best plants of this kind in the world. This means, of course, that quite a number of large American hydro-electric plants are illustrated in detail (for example, all those at Niagara on both sides of the river), matter which otherwise can only be found scattered in various periodicals published in this country and in Europe. It is reasonable to conclude, therefore, that the book will become an indispensable aid for all engineers who have to do with the design and installation of large and economical turbine power plants.

The theory of the turbine, or rules for design, are not given directly in the book. On the other hand, the careful reader cannot help gaining a large amount of information which will prove valuable in the study of theory and design. The author's comments and comparisons in connection with the several descriptions are much to the point. Still, the illustrations remain the most important feature of the book. They are of superior quality both as to selection and as to execution; this remark, by the way, applies equally to the two books noted above. The publishers deserve high praise for their work in this direction.

The fourth book under review, the monograph of Weidmann, is of quite different character from the preceding ones. It is essentially a theoretical study of the possibilities of the non-explosive or "constant-pressure" gas engine. The author first analyzes in detail the shortcomings of modern gas engines as compared especially with the steam engine and the steam turbine; he then proceeds to show what are the requirements of an economical, reliable, and well-governed engine. For these requirements he finds a solution in a gas engine working with a cycle in which the pressure remains constant during combustion, the air being compressed in the working cylinder, and the gas in a separate compressor cylinder; combustion takes place in a separate chamber next to the working cylinder. This description of the cycle advocated by the author gives but the main points; a large number of interesting details are worked out by the author, and he has gone so far as to design an engine of the two-stroke type which carries out his cycle. It is of course impossible to say, before such an engine has been built and tested, whether the author's ideas are practicable or not, though they seem quite promising. His conclusions with respect to the conditions for the best performance of a gas engine, viz., that combustion shall take place in a space protected as much as possible against loss of heat, that the amount of gas to be burned is to be regulated by the governor and by positive mechanical means, and that in fact both combustion and ignition should not be left to chance as much as in the ordinary gas engines, are undoubtedly sound.

The book is clearly written, and of excellent mechanical execution. It is certainly both interesting and original, and to those concerned with the development and the future of the gas engine a study of it will be well worth the trouble.

Coke and Coke Ovens.

COKE.—A Treatise on the Manufacture of Coke and Other Prepared Fuels and the Saving of By-Products, with Special References to the Methods and Ovens Best Adapted to the Production of Good Coke from the Various American Coals. By John Fulton, M. Am. Inst. Min. E., Scranton, Pa.: International Textbook Co. Cloth; 6 × 9¼ ins.; pp. 476; tables, folding plates, and many text illustrations. $5.

The first edition of this book was published ten years ago. The second edition is practically a new book.

The chapter on The Preparation of Coal for the Manufacture of Coke now occupies nearly 100 pages of space, and is the most complete treatment of the crushing and washing of coal which has yet appeared in book form. Coal crushing appliances are described and costs of crushing plants are given. The different types of coal washers are illustrated and discussed, followed by detailed descriptions of several complete plants, accompanied by two-page working plans, and in many cases by costs and results obtained.

Another valuable chapter (55 pages) is the one devoted to the manufacture of coke in the beehive oven. Working drawings of a number of ovens are given, and detailed estimates of the cost of ovens. This chapter is followed by one of 126 pages, equally good, on Retort and By-Product Coke Ovens. It includes detailed descriptions of such plants as the Otto-Hoffman plant at Lebanon, Pa., and the Semet-Solvay plant at Dunbar, Pa. Modern charging and coke pushing machinery is illustrated and described. First costs, as well as costs of operating many of the plants, are given.

Other chapters in the book have the following titles:

Coal Fields of North America; Formation and Chemical Properties of Coal; History and Development of the Coke Industry; Physical Properties of Charcoal, Anthracite and Coke, and a Comparison of Bee Hive and By-Product Coke; Laboratory Methods of Obtaining the Relative Calorific Values of Metallurgical Fuels; Locating of Plants for the Manufacture of Coke; General Conclusions on the Work; Costs and Products of Several Types of Coke Ovens; The Fuel Briquetting Industry.

This last chapter is foreign to the book, but in its 70 pages the author has given a satisfactory digest of the literature upon the subject.

Of the whole book it may be said that it forms a striking exception to the general run of books on mining engineering themes, not only in its wealth of practical details in the text, but in the number and general excellence of the illustrations.

L'ENERGIE HYDRAULIQUE ET LES RECEPTEURS HYDRAULIQUES.—By U. Masoni, Director and Professor of the Hydraulic Institute, Ecole Royale des Ingénieurs de Naples. Part of the Encyclopédie Industrielle, founded by C. Lechalas, retired Inspecteur-Général des Ponts et Chaussées. Paris: Gauthier-Villars. Paper; 6¼ × 10 ins.; pp. 320; 207 figures in the text. 10 fr.; $3 in the United States.

As the title indicates, this book is a treatise on hydraulic machines rather than on Hydraulics in general. Even the range of hydraulic machines is in this work limited to hydraulic prime movers, including the hydraulic ram, although a few pages are also given to hydraulic elevator machines. The treatment is mainly one of classification and mathematical discussion. Drawings and views, mediocre in their mechanical execution, are introduced in considerable number, but their purpose is only to illustrate classification and theory, not to exhibit detail construction. Large-scale or dimensioned drawings, such as would be of service in a practical study of the subject, are not given. The book is typically a text for a theoretical course in a technical college, but will hardly prove of much value for other uses.

HYDRAULIC POWER ENGINEERING.—A Practical Manual on the Concentration and Transmission of Power by Hydraulic Machinery. By G. Croydon Marks, Assoc. M. Inst. C. E., M. Inst. Mech. E. Second Edition, Enlarged. New York: D. Van Nostrand Co. London: Crosby Lockwood & Son. Cloth; 5½ × 8¼ ins.; pp. 388; 236 figures, partly in the text. $3.50, net.

This edition shows a net gain of about twenty pages over the previous one, including 40 new illustrations. Most of the new text relates to presses for baling, to hydraulic riveting and to turbines. The first edition was favorably reviewed in Engineering News of May 31, 1900. The contents of the present volume may be outlined as follows: Hydraulics, materials, packings and joints, valves, lifting machinery, presses, pumps, motors, and a variety of useful tables.

TWELFTH NATIONAL IRRIGATION CONGRESS.—Held at El Paso, Texas, Nov. 15 to 18, 1904. Official Proceedings. Compiled and Edited by Guy Elliott Mitchell, Chairman Press Bureau, by order the Executive Committee. (El Paso, Texas: A. W. Gifford, Secretary.) Paper; 6 × 9 ins.; pp. 442; four illustrations. $1.

A large number and quite a variety of papers on irrigation and allied subjects, including some phases of engineering, are included in this volume. Most of the matter is popular in character.

Cements, Limes, and Plasters:

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By EDWIN C. ECKEL, C. E.

Associate, American Society of Civil Engineers; Member, Society of Chemical Industry; Assistant Geologist, U. S. Geological Survey.

8vo, xxxiv + 712 Pages, 165 Figures, 254 Tables. Cloth, $6.00 Net

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French Testing Laboratory Bulletins.

BULLETIN DU LABORATOIRE D'ESSAIS MECANIQUES, PHYSIQUES, CHIMIQUES ET DE MACHINES DU CONSERVATOIRE NATIONAL DES ARTS ET METIERS.—Nos. 1 to 5. Paris, France: Ch. Beranger. Paper; 6½ × 9½ ins.; pp. 21, 43, 30, 129 and 9; illustrated.

These first five bulletins (1903-4) issued from the laboratory named above, contain papers and communications on a variety of topics. The first bulletin describes the organization and equipment of the new laboratory and the scheme of work which it proposes to undertake. In Bulletin 2 there are papers describing a number of European testing laboratories, a description of two German rotary kiln cement plants, a description of the Beeth filter, records of tests of rotary kiln cements and an explanation of a simple method of distinguishing hydraulic limes and fat limes. Bulletin 3 contains an unusually interesting paper by Mr. E. Leduc, of the laboratory staff, on the Effect of Sea Water on Mortars, and Bulletin 4 is devoted to a most elaborate paper of some 130 papers by Mr. Pierre Breuil, of the same staff, on the relation between dead load and live load stress effects on iron and steel. Bulletin 5 contains the paper presented at the International Congress of Physics at the St. Louis Exposition by Messrs. A. Perot and Charles Fabry on a standard unit for light wave length.

WESTERN RAILWAY CLUB.—Proceedings of the year 1904-1905. Western Railway Club, Old Colony Building, Chicago. Cloth; 6 × 9 ins.; pp. 450; illustrated.

The principal papers in this annual volume are as follows: (1) Back pressure and compression, I. C. Hubbell; (2) report on large grates and heating surfaces; (3) locomotive boiler maintenance, A. R. Raymer; (4) compressed air and its application, W. O. Duntley; (5) eyesight of enginemen, Dr. N. M. Black; (6) balanced compound locomotives, L. Fry; (7) railway accidents, S. Thompson; (8) cylinder clearance, O. W. Young; (9) employment of firemen, E. W. Pratt; (10) maintenance of repair shop machinery, M. K. Barnum; (11) tank locomotives, E. E. R. Tratman; (12) electricity on steam railways, C. F. Street.

ADMINISTRATION REPORT ON THE RAILWAYS IN INDIA.—To the calendar year 1904. Simla, India. Pub. Doc. Paper; 8½ × 13¼ ins.; pp. 271; folding map and diagram.

The report proper covers only about twelve pages, and shows a total railway system of 27,565 miles. The numerous appendices cover tabulated statements of mileage, finance, traffic, equipment, etc., for the individual railways. About 137 pages are devoted to historical statements of these various railways. The last appendix relates to the proposed standard designs for locomotives in India.

THE BERLIN-ZOSSEN ELECTRIC RAILWAY TESTS OF 1903.—A Report of the Test Runs Made on the Berlin-Zossen Railroad in the Months of September to November, 1903. Translated from the German by Franz Welz, E. E. With an Introduction Discussing the General Subject of Train Resistance, by Louis Bell, Ph. D., M. Am. Inst. E. E. New York: McGraw Publishing Co. Cloth: 8 × 11¼ ins.; pp. xvi. + 100; tables, 38 plates, and 18 text illustrations. $3, net.

The high-speed experiments of the famous "Studiengeseilschaft" on the Berlin-Zossen railway will for many years to come be among the sources of primary data in the subject of high-speed travel. They furnish almost the first accurate information available on car resistance at speeds of 100 miles per hour and over; they demonstrate, for the first time, the feasibility of collecting large amounts of power from a contact moving over a wire at these extreme speeds; and they add much corroborative evidence to the lessons of experience in high-speed railway travel as to proper construction of cars and track for safe high-speed running. Part of the results of these interesting experiments, the report on the runs last made, i. e., those of September to November, 1903, is made available to the exclusively English-reading public in the translation listed above. The work of the translator seems to have been done faithfully and intelligently, with only occasional lapses of expression. The translation has been extended also to the tables, drawings and curve-sheets which illustrate the report; most of the drawings and diagrams have been redrawn, relettered, and provided with co-ordinate scales in English units, and the tables have correspondingly been transformed to English units.

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MATHEMATICS OF THE PAPER LOCATION OF A RAILROAD, by Prof. J. C. L. Fish, Stanford University. Pamphlet 4½ x 7½ inches, 18 pages, price 25 cents.

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NICKEL STEEL.—Its Properties and Applications. By Albert Ladd Colby. Authorized Reprint from the Copyrighted Proceedings of the American Society for Testing Materials. Vol. III., 1903. Paper; 6 × 9¼ ins.; pp. 28; one plate.

The author presents briefly in this paper the early history of the investigations made by different scientists and metallurgists into the properties of steel alloyed with nickel. There follows a description of the manufacture of modern nickel-steel; a discussion of its physical properties and a statement of the uses to which it has been put. The paper is a concise and clear summary of its subject.

DISPOSAL OF HOUSEHOLD WASTES AT SUMMER RESORTS, ENCAMPMENTS AND FARM HOUSES.—Pure Water Supply and Other Sanitary Conditions. Prepared for the N. H. Board of Health by Robert Fletcher, Ph. D., Director of Thayer School of Civil Engineering, Dartmouth College, Member of the Board. Supplement N. H. Sanitary Bulletin, July, 1905. Concord, N. H.: Pub. Doc. Paper; 5¾ × 9 ins; pp. 21; 8 figures in the text.

Although the body of this bulletin needs revision to bring it up to date, new matter at the back nearly makes up the deficiency named. The New Hampshire State Board of Health and the author deserve commendation for the bulletin the contents of which are sufficiently indicated by the title. The bulletin contains more useful information than is to be found in some publications of far more pretension.

TRANSACTIONS OF THE AMERICAN CERAMIC SOCIETY.—Volume VII., Parts I. and II. Containing Papers and Discussions Read at the Meeting Held at Birmingham, Ala., Jan. 30 and Feb. 1, 1905, with Some Other Contributions. Columbus, O.: The Society. Paper; 6 × 9¼ ins.; pp. 1 to 152 and 153 to 282, respectively; illustrated.

The bulk of the papers in these volumes relate to matters of interest chiefly to manufacturers of pottery and stoneware. Two papers of interest to engineers are "Dry Pressed Brick," by Ellis Lovejoy, and "Causes of Body Crazing of Sewer-pipe," by Walter A. Hull.

RAILWAYS OF WESTERN AUSTRALIA.—Report for the year ended June 30, 1904. Perth, Western Australia: Pub Doc. Paper; 8¼ × 13 ins.; pp. 59; folding table; map and illustration.

This report shows that at the end of June, 1904, the Western Australian Government Railways had a total length of 1,541 miles. The report comprises the tabulated statistical information as to financial and traffic matters, and also the individual reports of the commissioner of railways, chief engineer, chief mechanical engineer, and other officials. The illustration is a drawing of the proposed new railway offices and terminal station at Perth.

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A German Handbook for Structural Steel Design.

DER EISENBAU.—A Handbook for Structural Steel Design. By Luigi Vianello. With an Appendix Containing Tables of I-s and Channels of all German Mills, by Gustav Schimpff. Munich and Berlin, Germany: R. Oldenbourg. Cloth; 5½ × 8½ ins.; pp. 691; tables, and 415 figures in the text. 17½ marks; American price, $7.

As a handbook or desk manual for the designer of steel framing this book is a pioneer, and on this account alone it merits appreciation. In both the English and the German literatures no work exists at present which is intermediate in character between the treatise on framed structures, on the one hand, and the pocket-book of useful information on the other. Yet there is great need for a book of just this kind: one which, besides giving in concentrated form both theoretical and practical information, gives help and guidance in the many and various problems arising in design.

These problems are of different kinds, and their grouping in accessible handbook form would be fully as difficult a problem as their collection and discussion. Most broadly speaking, they are mainly of semi-theoretical nature; they are theoretical because concerned with the determination of stresses and the disposition of material to resist these stresses—the major phase of structural design—while on the other hand they differ from the pure theory of Applied Mechanics in that the conditions are not mathematically definite, but may be indeterminate and even variable, so that the solution must be made by judgment and approximation. It is the discussion of such problems, their practical conditions and their proper solution, that forms the natural material for a handbook addressed to the structural designer. The book under notice represents an attempt to meet this idea. As will be seen, however, it fulfils only partly the requirements above suggested.

In its main portion it contains, in systematic arrangement, a concise summary of the principles and procedure of analyzing the stresses in framed structures and their elementary parts; intermingled therewith are many statements and suggestions in the direction of proper or economical design. The analysis of structures is arranged in accordance with the development of pure theory rather than practical utilization. The statics of simple and complex beams, and of plane and three-dimensional frames (both determinate and super-determinate) are consecutively treated. This matter forms the main body of the book (348 pp.) Another essential part comprises two chapters (162 pp.) that have less of theory than of practice: (1) A chapter on various special phases of stressing arising in practice, as the proportioning of main section and lattice in latticed struts, questions of riveting, splicing, bearing shoes, etc., etc.; (2) a chapter entitled Practical Data, which gives in amplified form some of the matter that would be covered by a specification for design and workmanship. Appended to the book is a series of tables, mainly of properties of sections, including also a reprint of Schimpff's "Trägertabellen" (listed elsewhere in these pages). The preceding summary has not mentioned several minor sections: short chapters on Mathematics, Mechanics and Masonry respectively, a total of 76 pages. The first chapter includes some mathematical tables (but no logarithms).

A great amount of matter is contained in this book which is not, or only with difficulty, available elsewhere. As a simple instance may be mentioned a discussion of the three-sided beam, a form which occurs rather frequently in mill-building work. However, the large amount of space devoted to frames and their stresses seriously reduces the amount of attention available for the fullest discussion of the "semi-theoretical" problems above referred to. The arrangement adopted by the author makes the book primarily a condensed treatise on stresses in frames, rather than a guide for the solution of problems lying beyond pure theory. As a result the several discussions of practical problems appear more as addenda than as principal features. A further consequence is that many important matters are altogether overlooked, as for example: struts, column bases, column footings, beam connections, stresses in columns with partly fixed bases, stresses in beams riveted between girders or columns, expansion-provision, and a host of others that might be mentioned.

Several other omissions or faults attract attention in a perusal of the book. The analysis of frames under wheel-loads seems to be entirely passed over. The tabular and "miscellaneous" information which is looked for in a book of this kind is altogether too scanty and scattered to meet the needs of the structural designer; this fault is aggravated by an index much too brief to do justice to the contents. It might be expected, again, that representative specifications would find a place in such a book; but only a partial equivalent is contained in the last chapter. This last chapter, in fact, would, according to American ideas, be worked out in much different form, by sample specifications, data-tables, discussion of the peculiarities of bridge, mill-building and tier-building work, etc. As it is, the reader looks in vain for allowable crane-load stresses, just as in the preceding chapter on Special Problems he finds nothing on crane track design. Concrete data such as the probable loading to be met in various classes of building work are equally absent.

The book merits praise as a pioneer structural engineers' handbook, and as a concise, suggestive

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EARTH AND ROCK EXCAVATION
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Extract of Review from the Engineering News of June 15, 1905:

"Mr. Prelini has given us a book on a much neglected subject in engineering literature, and it is one that should find a place in every engineer's library, while contractors will find many things of value in it. Although the author has given some cost data, yet his book is not meant as a discussion of the cost of various methods of making earth and rock excavation, but rather of the planning and modes of executing both large and small jobs of excavation. The student of engineering will find this book an immense aid towards making him familiar with the different methods of performing excavation before his college days are over. Every technical school should use Prelini's treatise as a textbook, or else require the students to read it as a supplement to their studies. For a technical treatise, the author has handled his subject well, and has written in an attractive style. He seems to be an enthusiast on his work and profession, and has thrown much of his own spirit into the text.

About 40 per cent. of the book is taken up with the hauling or transportation of excavated material, and there has never, so far as the reviewer is aware, appeared in print, as much information on the subject, nor has it been presented in as masterly a manner. If the volume contained nothing else, it would be of value for this one subject. When excavation is made by hand, the hauling is important, but the picking and shoveling amounts to more in cost; but nothing is so important as the hauling when machines are used, as the hauling is one of the large cost items, both in labor and plant, and if the material is not carried away promptly the machine must stop work. Consequently, excavation becomes a matter of transporting the excavated materials. Mr. Prelini goes into the matter in detail and at great length, and discusses the subject under four heads:

(1) When the earth is hauled on horizontal roads, or roads having only a small gradient.

(2) When roads are very steep, and consequently the materials must be hauled along inclines.

(3) When the materials are hauled in a vertical direction, or hoisted.

(4) When the materials, instead of being transported on roads laid on the ground surface, are hauled on roads suspended in the air.

In considering the treatise as a whole, it is certainly to be commended, as the book will not only be useful to the student, but also to contractors and the engineering profession."

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and helpful manual. Its typography and general finish are equally creditable. A book of similar purpose is certain of a good reception in America, a field for which the detail criticisms above offered have perhaps more validity than for the European field of the present book.

Additional German Literature.

LEHRBUCH DER BAUMATERIALIENKUNDE.—Zum Gebrauche an Technischen Hochschulen und zum Selbststudium. By Max Foerster, Professor of Structural Engineering at the Dresden Royal Technical College. Leipzig: Wilhelm Engelmann. Paper; 7⅛ × 11 ins.; Part I., pp. 118; Part II., Section 1, pp. 128; illustrated. 4 and 5 M. American price, $1.60 and $2, respectively.

The two pamphlets before us are a portion of what is intended to be a complete treatise on Materials of Construction. The plan includes six parts: I., Natural Stones; II., Artificial Stones; III., Wood; IV., Metals; V., Cements (mortars, asphalts, lutes); VI., Miscellaneous materials (glass, paints, finish materials, etc.) It appears that only a small part of the work is contained in the present two pamphlets, especially as the second covers only half of Part II., it being intended to treat of brick and tile in a separate pamphlet.

The treatment of the subject, in both the pamphlets under notice, is of course almost exclusively descriptive. Under the head Natural Stones the author groups and describes the different useful varieties of stones (European), noting composition, appearance, location and principal properties. He then treats very briefly of the winning and working of stone, a little more fully of testing and tests, and concludes with some notes on the use of stone in architectural and engineering construction. The pamphlet on Artificial Stones opens with a discussion of manufacture and testing, and then describes in classified arrangement the many different kinds of cemented block (including under this head glass blocks, vault lights, asphalt block and the like). As already noted, fired blocks (brick and tile) are to be treated separately. Both pamphlets contain extensive bibliographical appendices.

In general the work does not promise special value for American conditions. The collection of descriptions of artificial stones and their manufacture may, however, frequently prove of value on this side of the water.

STUDIE UBER DIE BESTIMMUNG DER NORMALPROFILE GESCHIEBEFUEHRENDER GEWASSER.—Reprinted from the "Zeitschrift des Oesterreichischen Ingenieur und Architekten Vereins," 1905. By Richard Siedek. Vienna (Austria): Wilhelm Braumüller. Paper; 10½ × 13½ ins.; pp. 16; four plates and 9 figures in the text. 2½ marks; American price, $1.

The author here extends his previously-advanced ideas concerning normal cross sections of streams. He deduces a relation between mean depth and slope, coming to the conclusion that for given mean velocity the mean depth varies inversely as the square root of the slope. He had previously advanced a relation between breadth and mean depth of the normal cross section, in the form (metric):

$$d = \sqrt{0.0175\ b - 0.0125}.$$

Combining the two results with an expression for velocity in terms of depth, breadth and slope, he has computed a diagram giving curves of equal cross sections and curves of equal velocities, on coordinates of discharge and slope. A long table is also given showing the agreement of nearly 300 actual cross section data with the values taken from the diagram. The application of the theory to river improvement work is also discussed.

AUGENBLICKLICHER STAND DER ABWASSERREINIGUNG NACH DEM SOGENANNTEN BIOLOGISCHEN VERFAHREN.—By Dr. A. Thumm, Member of the Royal Testing Laboratory for Water Supply and Sewage Disposal at Berlin. (Reprint of a Lecture before the Sewage Committee of the Berlin Agricultural Society, February, 1905.) Berlin, Germany: Pub. Doc., or address the author, 73 Kochstrasse, Berlin, Germany. Paper; 6 × 9 ins.; pp. 20.

The German attitude towards septic tanks and rapid filters for the treatment of sewage is conservative. Little has been done in Germany along these lines of sewage treatment and that little has been mostly experimental. In this pamphlet the author discusses the various so-called bacterial methods of sewage treatment and gives cost figures based on British and, to slight extent, German practice. He believes that costs of both construction and operation have been underestimated; and that while good results may be secured from contact beds and from percolating filters, preceded by either settling or septic tanks, yet for the present broad irrigation is still to be preferred in Germany.

DIE NEUESTE ENTWICKLUNG DER WASSERHALTUNG und Versuche mit verschiedenen Pumpen systemen, by Professor Baum. Berlin: Julius Springer. Paper; 9 × 11¼ ins.; pp. 116; 9 folding plates, and many text illustrations. 4 M. American price, $1.00.

This monograph on Mine Pumping Plants is a reprint from the journal "Glückauf" and comprises two separate parts: 1, a descriptive article on Modern Mine Pumping Plants, devoted mainly to electric motor-driven plants, with both rotary and plunger pumps; 2, a report on a series of tests made two years ago on a number of mine pumping plants in Germany, the tests having been conducted by several technical and industrial societies in co-operation, and covering steam, hydraulic and electric plants. The book is profusely illustrated with drawings and halftones.

TRAEGER-TABELLE.—Zusammenstellung der Hauptwerte der von deutschen Walzwerken hergestellten I-und [-Eisen. Nebst einem Anhange: Die englischen und amerikanischen Normalprofile. Edited by Gustav Schimpff. Munich and Berlin: R. Oldenbourg. Boards; 8½ × 6 ins.; pp. 59. 2 marks; American price, 80 cts.

This book is a list of standard and special I-beams and channels in the German steel market arranged according to size. An appendix gives the new British Standards Committee's standard sizes for I-beams and channels, and the American Steel Manufacturers' Association standards. The tabulation is uniform throughout the book, giving depth, flange width, thickness of web and flange, section weight, location of center of gravity, and moments of inertia.

INQUIRY INTO TELEPHONE SERVICE AND RATES IN NEW YORK CITY BY THE MERCHANTS' ASSOCIATION OF NEW YORK.—(New York: The Association, S. C. Mead, Secretary.) Stiff paper; 8 × 11 ins.; pp. 57; two folding sheets and three diagrams.

The results of this notable inquiry (the voluntary reduction of rates) were commented on at some length in Engineering News for March 30, 1905. The report contains valuable and suggestive information on the telephone service as related to just charges and public policy.

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GOLD DREDGING.—By Captain C. C. Longridge, M. Inst. M. E., Author of "Hydraulic Mining" (3 Parts), "Glossary of Mining Terms," "Wet and Dry Treatment of Copper Ores," "A Précis of Land Smelting," etc. London, England: The Mining Journal. Cloth; 6¼ × 10 ins.; pp. 194; folding and other plates, and text illustrations.

GOLD DREDGING IN CALIFORNIA.—Issued by the California State Mining Bureau, Ferry Building, San Francisco. Lewis E. Aubury, State Mineralogist. Bulletin No. 36. San Francisco, Cal.: Pub. Doc. Paper; 6 × 9 ins.; pp. 201; tables, four folding maps and 66 figures in the text. 50 cts.; by mail, 56 cts.

GOLD AND TIN DREDGING PRACTICE.—By H. L. Lewis. (Reprinted from "The Mining Journal.") London, England: "The Mining Journal." Paper; 8½ × 11 ins.; pp. 16; illustrated. 1s., net; American price, 40 cts.

METHODS AND COSTS OF GRAVEL AND PLACER MINING IN ALASKA.—By Chester Wells Purington. Bulletin 263, U. S. Geological Survey, Washington, D. C.: Pub. Doc. Paper; 6 × 9 ins.; pp. 273; xiii. plates and 49 figures in the text.

Of these four publications the only one that is a bound volume is the work on "Gold Dredging" by Longridge. In its general method of treating the subject, however, it does not differ materially from the bulletin on "Gold Dredging in California." Longridge has given a larger number of photographs, and has made a more general use of catalogue text and cuts. He has also abstracted a greater number of articles that have appeared in technical journals, particularly English journals; and, in a word, he has made a greater effort to produce a comprehensive book on the subject of gold dredging than would naturally be expected of an author of a State bulletin. Nevertheless, the State bulletin does not suffer by comparison—in fact, for American readers it possesses many points of superiority. It gives, for example, more complete tables of data on the cost of gold dredging. Indeed, the weak feature of the book by Longridge is the meagerness of the cost data. On the other hand, for any one who is ignorant of the recent literature on the subject, "Gold Dredging" will be a valuable book of reference. The author discusses briefly the different types of dredges and their respective adaptability to different conditions. He enters somewhat into the design of the endless bucket dredge, and gives data on the horse-power required. Then the subject of screening the gravel and recovering the gold is discussed—not in as great detail as the importance of this feature of a gold dredging plant merits, but still in sufficient detail to give many valuable hints. The chapter on the disposal of the tailings is altogether too brief. The author has evidently overlooked most of the good articles that have appeared on this subject. The chapters on "Selecting and Prospecting Ground," and "Fields for Gold Dredging" will prove of value not only to mining engineers but to business men who are interested in placer mining projects.

Passing now to the bulletin on "Gold Dredging in California," by Aubury, we find one of the best written and most valuable of public documents that we have received in a long time. A large map shows the gold dredging lands adjacent to Feather River, and the exact location of each dredge. Photographs of a large number of dredges appear as illustrations in the text. As above stated, the matter that will particularly interest engineers and mining men is contained in the section devoted to costs. Tables are given showing not only the detailed costs, but the percentages of lost time and the causes of delays. Rates of wages are not given in all cases, which is a serious omission, particularly as wages in California are often very high even for common laborers. However, wages paid in most of the districts are stated, so that by a little study a fairly close analysis of costs is possible.

The third publication under review, "Gold and Tin Dredging Practice," is a reprint of several articles that originally appeared in "The Mining Journal." There are some good hints in this pamphlet, and it is apparent that the author speaks from personal experience. The article on "The Submerged Jet Dredge" is well worth reading.

The fourth publication, "Methods and Costs of Gravel and Placer Mining in Alaska," contains matter not only on gold dredging, but on hydraulicking and other methods used by placer miners. What we have said as to the excellence of the California bulletin applies equally well to this bulletin. It is well written and it contains facts and figures of value. One feature of this bulletin worthy of special note is the hints given on economic methods of excavating. The author has not confined himself to a mere description of methods now used in Alaska, but has called attention to, and, in some cases, has illustrated and described methods used successfully elsewhere. The bulletin should, therefore, be of great value not only to engineers and mining men in Alaska, but also to all men who are engaged in open cut excavating or in placer mining.

THE SANITATION OF A COUNTRY HOUSE.—By Dr. Harvey B. Bashore, Inspector for State Board of Health of Pennsylvania, Author of "Outlines of Rural Hygiene." New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 5 × 7½ ins.; pp. 103; 16 illustrations. $1.

These well written notes present in popular form such of the elementary principles of house sanitation as are most needed and most readily acted upon by people who lack the benefits of municipal public services. After considering the location of the house and the house itself, the author writes of water supply, waste disposal and general surroundings. He concludes with an eminently practical chapter on the summer camp. About the only omissions of importance that we have noted are (1) suggestions as to the disposal of garbage by burning in the kitchen fire, either direct or after drying in a receptacle placed in the stove pipe, and (2) comments on the importance of safe-guarding the milk supply. The price of the book seems high for the amount of information given, but the book is well made and has a number of illustrations.

CONNECTICUT HIGHWAY COMMISSIONER.—Report for the Years 1903 and 1904. Hartford, Conn.: James H. Macdonald, Highway Commissioner. Paper; 6 × 9 ins.; pp. 263 + 71; illustrated.

In addition to the usual reprint of specifications for roadwork and the State laws under which roads are built, some good hints are given on the maintenance of roads. A list of the different contracts finished during the year 1903 shows the amount of road work done and its general character, as well as the contract price.

(Continued on page 178.)

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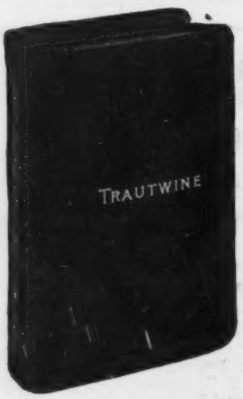

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